IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re PATENT APPLICATION of   Group Art Unit: 1754
Inventor(s): Mills

App'n Ser. No.: 09/110,694   Examiner(s): Kalafut for the
                                                            Secret Committee

Filing Date: 07/07/1998

Title: REACTOR FOR PREPARING HYDROGEN COMPOUNDS

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March 8, 2005

FURTHER RESPONSE TO FINAL OFFICE ACTION AND
REQUEST FOR CONTINUED PROSECUTION

Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Applicant files this paper in response to the Final Office Action mailed February 10, 2004. This Response is supplemental to the Response filed August 9, 2004, to which no Advisory Action has been issued. Please consider this paper a Petition for a five-month extension and a Request for Continued Prosecution.

Reconsideration and allowance of the subject application are respectfully requested. Claims 1-326 are pending in the application.

Submitted with this Response is new, non-cumulative scientific evidence further demonstrating the existence of lower energy states of hydrogen in many different ways, including, but not limited to, studies of spectroscopic lines, energy output, compositions of matter, generated plasmas, and inverted hydrogen populations. As detailed below, Applicant also identifies independent third-party data pursuant to the PTO's agreement, which evidence resulted in verbal confirmation by Examiner Wayne Langel that two BlackLight applications handled by him were allowable before he was told to

misrepresent that fact and, thus, was forced to resign from examining those cases "for moral and ethical reasons."

Despite the PTO's official "allowance is not an option" policy, as revealed by Examiner Langel and confirmed by two other Examiners, Applicant must insist that the anonymous group of individuals, i.e. the "Secret Committee," responsible for directing the named Examiner's actions in this case properly consider and evaluate in detail this and all other scientific evidence of record, which so far has been essentially ignored. To the limited extent that the Committee has begun to address Applicant's evidence in any of his pending cases, it has done so by relying primarily upon the biased views of one of its principal members, Dr. Bernard Eng-Kie Souw. As discussed below, those biased views lack credibitility not just on the merits, but also due to a genuine conflict of interest involving Dr. Souw's contemporaneous ownership of, and work as the lead scientist for, a company that competes with BlackLight in the same technical areas. Consequently, the Committee's rejections in all of BlackLight's cases, including this one, which have adopted Dr. Souw's biased views, are fatally defective and should be immediately withdrawn so that these cases can be allowed to issue.

The rejection of the claims 1-326 under 35 U.S.C. § 101 as being inoperative and lacking utility is respectfully traversed. Applicant respectfully submits that the Committee has not met its burden of raising a *prima facie* case of inoperability for the many reasons of record and, therefore, the rejection should be withdrawn for those reasons alone. Furthermore, Applicant has disclosed substantial experimental evidence in the present disclosure, prior submissions, and submissions herewith that fully rebut any *prima facie* case of inoperability the Committee might have raised. Applicant responds more fully to the Committee's comments, discusses the experimental evidence of record, and summarizes the improper prosecution procedures used by the Committee in the following paragraphs. For these additional reasons, the Section 101 rejection should be withdrawn.

The related rejection of claims 1-326 under 35 U.S.C. § 112, first paragraph, as lacking enablement, is also respectfully traversed. Applicant respectfully submits that the Committee has not met its burden of raising a *prima facie* case of lack of enablement for the many reasons of record and, therefore, the rejection should be

withdrawn for those reasons alone. Furthermore, Applicant has disclosed substantial experimental evidence in the present disclosure, prior submissions, and submissions herewith that fully rebut any *prima facie* case of lack of enablement the Committee might have raised. Applicant responds more fully to the Committee's comments, discusses the experimental evidence of record, and summarizes the improper prosecution procedures used by the Committee in the following paragraphs. For these additional reasons, the Section 112, first paragraph, rejection should be withdrawn.

Applicant also files herewith a Rule 132 Declaration certifying his newly submitted experimental evidence, which further rebuts the Committee's unjustified utility and enablement rejections of the claimed invention. This evidence, which the Committee required Applicant to make public by submitting it to scientific journals for publication, conclusively confirms the formation of lower-energy hydrogen through practice of Applicant's novel hydrogen chemistry. To this day, the Committee has failed to properly consider the numerous Rule 132 Declarations previously filed by Applicant in violation of its own rules, as outlined in MPEP § 716:

> Evidence traversing rejections must be considered by the examiner whenever present. All entered affidavits, declarations, and other evidence traversing rejections are acknowledged and commented upon by the examiner in the next succeeding action. ... Where the evidence is insufficient to overcome the rejection, the examiner must specifically explain why the evidence is insufficient. General statements such "the declaration lacks technical validity" or "the evidence is not commensurate with the scope of the claims" without an explanation supporting such findings are insufficient. [Emphasis added.]

The Committee does not even mention, let alone consider, most of the certified experimental evidence identified in Applicant's Rule 132 Declarations that were submitted to overcome the rejections of record.

Lower-Energy Hydrogen Experimental Data

With this latest submission, Applicant now has over 100 articles and books of record in this case, as reflected in the "List of References" set forth below. These articles detail studies that experimentally confirm a novel reaction of atomic hydrogen, which produces hydrogen in fractional quantum states that are at lower energies than

the traditional "ground" ($n = 1$) state, a chemically generated or assisted plasma (rt-plasma), and novel hydride compounds, including:

extreme ultraviolet (EUV) spectroscopy,[1]

characteristic emission from catalysis and the hydride ion products,[2]

lower-energy hydrogen emission,[3]

plasma formation,[4]

Balmer α line broadening,[5]

population inversion of hydrogen lines,[6]

elevated electron temperature,[7]

anomalous plasma afterglow duration,[8]

power generation,[9]

excessive light emission,[10] and

analysis of chemical compounds.[11]

In addition, Applicant has shown that direct plasma to electric power conversion is possible using this novel hydrogen chemistry.[12]

A summary of Applicant's experimental data confirming the existence of lower-energy hydrogen is set forth below:

1.) the observation of intense extreme ultraviolet (EUV) emission at low temperatures (e.g. $\approx 10^3 \ K$) from atomic hydrogen and only those atomized elements or gaseous ions which provide a net enthalpy of reaction of approximately $m \cdot 27.2 \ eV$ via the ionization of t electrons to a continuum energy level where t and m are each an integer (e.g. K and Cs atoms and Rb^+ and Sr^+ ions ionize at integer multiples of the potential energy of atomic

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[1] Reference Nos. 11-16, 20, 24, 27-29, 31-36, 39, 42-43, 46-47, 50-52, 54-55, 57, 59, 63, 65-68, 70-76, 78-79, 81, 83, 85, 86, 89, 91-93, 95-96, 98, 101, 104.

[2] Reference Nos. 24, 27, 32, 39, 42, 46, 51-52, 55, 57, 68, 72-73, 81, 89, 91

[3] Reference Nos. 14, 28-29, 33-36, 50, 63, 67, 70-71, 73, 75-76, 78-79, 86-87, 90, 92, 93, 98, 101, 104

[4] Reference Nos. 11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91-93

[5] Reference Nos. 16, 20, 30, 33-37, 39, 42-43, 49, 51-52, 54-55, 57, 63-65, 68-69, 71-74, 81-85, 88-89, 91, 92, 93, 95-97, 105

[6] Reference Nos. 39, 46, 51, 54, 55, 57, 59, 65-66, 68, 74, 83, 85, 89, 91

[7] Reference Nos. 34-37, 43, 49, 63, 67, 73

[8] Reference Nos. 12-13, 47, 81

[9] Reference Nos. 30-31, 33, 35-36, 39, 43, 50, 63, 71-73, 76-77, 81, 84, 89, 92, 93, 98, 101, 104

[10] Reference Nos. 11, 16, 20, 23, 31, 37, 43, 52, 72

[11] Reference Nos. 6-10, 19, 25, 38, 41, 44-45, 60-62, 64, 69, 75, 81-82, 87-88, 90, 92, 93, 94, 98, 100, 101, 104

[12] Reference Nos. 18, 26, 40, 48, 56, 68

hydrogen and caused emission; whereas, the chemically similar atoms, Na, Mg, and Ba, do not ionize at integer multiples of the potential energy of atomic hydrogen and caused no emission)[13],

2.) the observation of novel EUV emission lines from microwave and glow discharges of helium with 2% hydrogen with energies of $q \cdot 13.6 \, eV$ where $q = 1,2,3,4,6,7,8,9,11,12$ or these lines inelastically scattered by helium atoms in the excitation of $He \, (1s^2)$ to $He \, (1s^1 2p^1)$ that were identified as hydrogen transitions to electronic energy levels below the "ground" state corresponding to fractional quantum numbers[14],

3.) the observation of novel EUV emission lines from microwave and glow discharges of helium with 2% hydrogen at 44.2 nm and 40.5 nm with energies of

$$q \cdot 13.6 + \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right) X13.6 \, eV$$ where $q = 2$ and $n_f = 2,4$ $n_i = \infty$ that corresponded to multipole

coupling to give two-photon emission from a continuum excited state atom and an atom undergoing fractional Rydberg state transition[15],

4.) the identification of transitions of atomic hydrogen to lower energy levels corresponding to lower-energy hydrogen atoms in the extreme ultraviolet emission spectrum from interstellar medium and the sun[16],

5.) the observation that the novel EUV series of lines with energies of $q \cdot 13.6 \, eV$ was observed with an Evenson microwave cell, only the peak corresponding to $q = 2$ was observed with an RF cell, and none of the peaks were observed with a glow discharge cell[17],

6.) the observation that in a comparison of Evenson, McCarroll, cylindrical, and Beenakker microwave cavity plasmas, the novel EUV series of lines with energies of $q \cdot 13.6 \, eV$ was only observed for Evenson-cavity helium-hydrogen plasmas[18],

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[13] Reference Nos. 11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91-93
[14] Reference Nos. 28, 33-36, 50, 63, 67, 71, 73, 75-76, 78, 86-87, 90
[15] Reference Nos. 36, 71, 73
[16] Reference Nos. 1, 5, 17, 28-29
[17] Reference Nos. 71, 73
[18] Reference No. 76

7.) the EUV spectroscopic observation of lines for a hydrogen-K catalyst plasma by the Institut für Niedertemperatur-Plasmaphysik e.V. that could be assigned to transitions of atomic hydrogen to lower energy levels corresponding to fractional principal quantum numbers and the emission from the excitation of the corresponding hydride ions[19],

8.) the recent analysis of mobility and spectroscopy data of individual electrons in liquid helium which shows direct experimental confirmation that electrons may have fractional principal quantum energy levels[20],

9.) the observation of novel EUV emission lines from microwave discharges of argon or helium with 10% hydrogen that matched those predicted for the reaction $H(1/4) + H^+ \rightarrow H_2(1/4)^+$ having an energy spacing of 2^2 times the transition-state vibrational energy of H_2^+ with the series ending on the bond energy of $H_2(1/4)^{+}$ [21],

10.) the result that the novel vibrational series for the reaction $H(1/4) + H^+ \rightarrow H_2(1/4)^+$ was only observed for catalyst plasmas of helium, neon, and argon mixed with hydrogen, but not with noncatalyst xenon or krypton mixed plasmas[22],

11.) the observation that based on the intensities of the peaks, the catalyst and the plasma source dependence of the reaction rate to form $H_2(1/4)^+$ is $Ar^+ > He^+ > Ne^+$ and microwave > glow discharge >> RF, respectively[23],

12.) the observation that the microwave plasma source dependence of the reaction rate to form $H_2(1/4)^+$ is Evenson microwave > McCarroll, cylindrical, Beenakker[24],

13.) the observation of rotational lines in the 145-300 nm region from atmospheric pressure 15 keV electron-beam excited argon-hydrogen plasmas where the unprecedented energy spacing of 4^2 times that of hydrogen established the internuclear distance as 1/4 that of H_2 and identified $H_2(1/4)^{25}$,

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[19] Reference No. 14
[20] Reference Nos. 17, 53
[21] Reference Nos. 29, 70, 73, 79, 92, 93, 98, 101, 104
[22] Reference Nos. 29, 70, 73, 79, 92, 93, 101
[23] Reference No. 70
[24] Reference No. 79
[25] Reference Nos. 98, 101, 104

14.) the observation of a series of vibration-rotational bands in the 60-67 nm region, a high-energy region for which vibration-rotational spectra are ordinarily unknown, emitted from low-pressure helium-hydrogen (99/1%) microwave plasmas that matched the predicted energy spacing of the vibrational energy of H_2 about the bond energy of $H_2(1/2)$ corresponding to the reaction $2H(1/2) \rightarrow H_2(1/2)$[26],

15.) the observation of EUV plasma emission spectra in the region $60\ nm$ to $100\ nm$ that matched the predicted emission lines E_{DH_2} due to the reaction $2H(1/2) \rightarrow H_2(1/2)$ with vibronic coupling at energies of $E_{D+vib} = 17.913 \pm \left(\dfrac{\upsilon*}{3}\right) 0.515902\ eV$ to longer wavelengths for $\upsilon* = 2$ to $\upsilon* = 32$ and to shorter wavelengths for $\upsilon* = 1$ to $\upsilon* = 16$ to within the spectrometer resolution of about $\pm 0.05\%$[27],

16.) the observation that in addition to members of the series of novel emission lines with energies of $q \cdot 13.6\ eV$ or $E_{D+vib} = 17.913 \pm \left(\dfrac{\upsilon*}{3}\right) 0.515902\ eV$ an additional intense peak was observed from a scaled-up Evenson cell at $41.6\ nm$ with an energy of $29.81\ eV$ that matched $q \cdot 13.6\ eV$ with $q = 4$ less $24.58741\ eV$ corresponding to inelastic scattering of these photons by helium atoms due to ionization of He to He^+[28],

17.) the observation that in a comparison of Evenson, McCarroll, cylindrical, and Beenakker microwave cavity plasmas, the novel series of spectral lines due to the reaction $2H(1/2) \rightarrow H_2(1/2)$ with vibronic coupling at energies of $E_{D+vib} = 17.913 \pm \left(\dfrac{\upsilon*}{3}\right) 0.515902\ eV$ was only observed for Evenson-cavity helium-hydrogen and neon-hydrogen plasmas[29],

18.) the observation by gas chromatography that hydrogen was consumed by the helium-hydrogen plasmas which showed the novel EUV series of lines with energies of $q \cdot 13.6\ eV$, the novel series of spectral lines due to the reaction $2H(1/2) \rightarrow H_2(1/2)$ with vibronic coupling at energies of $E_{D+vib} = 17.913 \pm \left(\dfrac{\upsilon*}{3}\right) 0.515902\ eV$, extraordinary H Balmer line broadening corresponding to $180 - 210\ eV$, and excess power of 21.9 W in 3 cm^3[30],

[26] Reference No. 99
[27] Reference Nos. 50, 75-76, 78, 86-87, 90
[28] Reference No. 86
[29] Reference No. 76
[30] Reference No. 76

19.) the observation of the dominant He^+ emission and an intensification of the plasma emission observed when He^+ was present with atomic hydrogen demonstrated the role of He^+ as a catalyst[31],

20.) the observation of continuum state emission of Cs^{2+} and Ar^{2+} at 53.3 nm and 45.6 nm, respectively, with the absence of the other corresponding Rydberg series of lines from these species which confirmed the resonant nonradiative energy transfer of 27.2 eV from atomic hydrogen to the either Cs or Ar^+ catalyst[32],

21.) the spectroscopic observation of the predicted hydride ion $H^-(1/2)$ of hydrogen catalysis by either Cs or Ar^+ catalyst at 407 nm corresponding to its predicted binding energy of 3.05 eV[33],

22.) the observation of characteristic emission from K^{3+} which confirmed the resonant nonradiative energy transfer of $3 \cdot 27.2$ eV from atomic hydrogen to atomic K[34],

23.) the spectroscopic observation of the predicted $H^-(1/4)$ ion of hydrogen catalysis by K catalyst at 110 nm corresponding to its predicted binding energy of 11.2 eV[35],

24.) the observation of characteristic emission from Rb^{2+} which confirmed the resonant nonradiative energy transfer of 27.2 eV from atomic hydrogen to Rb^+[36],

25.) the spectroscopic observation of the predicted $H^-(1/2)$ ion of hydrogen catalysis by Rb^+ catalyst at 407 nm corresponding to its predicted binding energy of 3.05 eV[37],

26.) the observation of $H^-(1/2)$, the hydride ion catalyst product of K^+ / K^+ or Rb^+, at its predicted binding energy of 3.0468 eV by high resolution visible spectroscopy as a continuum threshold at 4068.2 Å and a series of structured peaks separated from the binding

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[31] Reference Nos. 36, 73
[32] Reference Nos. 24, 39, 51, 54-55, 57, 91
[33] Reference No. 24
[34] Reference Nos. 27, 39, 42, 46, 51, 54-55, 57, 81, 89, 91
[35] Reference Nos. 81, 42, 27
[36] Reference Nos. 32, 39, 42, 46, 51, 54-55, 57, 81, 89, 91
[37] Reference No. 32

energy by an integer multiple of the fine structure of $H(1/2)$ starting at 4071 Å that matched predicted free-free transitions[38],

27.) the observation that the high resolution visible K^+/K^+ or Rb^+-H_2 plasma emission spectra in the region of 3995 to 4060 Å matched the predicted bound-free hyperfine structure lines E_{HF} of $H^-(1/2)$ calculated from the electron g factor as $E_{HF} = j^2 3.00213 \, X \, 10^{-5} + 3.0563 \, eV$ (j is an integer) for $j = 1$ to $j = 39$ (3.0563 eV to 3.1012 eV—the hydride binding energy peak plus one and five times the spin-pairing energy, respectively) to within a 1 part per 10^4 [39],

28.) Rb^+ or $2K^+$ catalysts formed a plasma having strong VUV emission with a stationary inverted Lyman population with an overpopulation sufficient for lasing, and emission from $H^-(1/2)$ was observed at 4071 Å corresponding to its predicted binding energy of $3.0468 \, eV$ with the fine structure and its predicted bound-free hyperfine structure lines $E_{HF} = j^2 3.00213 \, X \, 10^{-5} + 3.0563 \, eV$ (j is an integer) that matched for $j = 1$ to $j = 37$ to within a 1 part per 10^4 [40],

29.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing at wavelengths over a wide range from micron to blue wherein molecular oxygen served as the catalyst as supported by O^{2+} emission and H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone[41],

30.) the observation of H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone at distances up to 5 cm from the coupler[42],

31.) the observation that with a microwave input power of 9 $W \cdot cm^{-3}$, a collisional radiative model showed that the hydrogen excited state population distribution was consistent with an $n = 1 \rightarrow 5,6$ pumping power of an unprecedented 200 $W \cdot cm^{-3}$ permissive of gas laser efficiencies orders of magnitude those of conventional visible gas lasers and

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[38] Reference Nos. 39, 42, 46, 57, 81, 89, 91
[39] Reference Nos. 39, 42, 46, 57, 81, 89, 91
[40] Reference Nos. 39, 42, 46, 51, 54, 55, 57, 81, 89, 91
[41] Reference Nos. 59, 65-66, 68, 74, 83, 85
[42] Reference No. 74

direct generation of electrical power using photovoltaic conversion of the spontaneous or stimulated water vapor plasma emission[43];

32.) the observation of stimulation of the stationary inverted H Balmer population from a low pressure water-vapor microwave discharge plasma by back illumination with an infrared source that showed depopulation of the $n = 5$ state[44],

33.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing was observed for Evenson microwave plasmas, but not for RF or discharge plasmas[45],

34.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing that was dependent on the microwave plasma source with the highest inversion from Evenson microwave plasmas[46],

35.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing that was dependent on the pressure of the Evenson microwave plasma[47],

36.) the observation of stationary inverted H Balmer populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing at distances up to 5 cm from the coupler[48],

37.) the observation that the requirement for the natural hydrogen-oxygen stoichiometry of the Evenson water plasma was stringent in that a deviation by over 2% excess of either gas caused a reversal of the H inversion in water vapor plasmas[49],

38.) the observation of a typical slow H population for a water-vapor plasma maintained in a GEC-type cell that was independent of time, and a new phenomenon, an

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[43] Reference Nos. 68, 83, 85
[44] Reference Nos. 59, 65, 68, 85
[45] Reference Nos. 59, 65-66, 68, 73, 83, 85
[46] Reference No. 83
[47] Reference Nos. 59, 68, 73, 83, 85
[48] Reference No. 74
[49] Reference Nos. 59, 68, 83, 85

extraordinary fast population that increased from zero to a significant portion of the Balmer α emission with time under no-flow conditions wherein the peak width and energy increased with time up to a 0.7 nm half-width corresponding to an average hydrogen atom energy of 200 eV[50],

39.) the observation of a substantial fast H population (~20% at 40 eV) for a water-vapor plasmas maintained in a GEC-type cell that was independent of position including regions were the electric field was orders of magnitude to low to explain the extraordinarily high Doppler energies[51],

40.) the observation of fast H population (40-50 eV) for He/H_2 (95/5%), Ar/H_2 (95/5%), and H_2 plasmas maintained in a GEC-type cell that was independent of position including regions were the electric field was orders of magnitude to low to explain the extraordinarily high Doppler energies[52],

41.) the observation by the Institut für Niedertemperatur-Plasmaphysik e.V. of an anomalous plasma and plasma afterglow duration formed with hydrogen-potassium mixtures[53],

42.) the observation of anomalous afterglow durations of plasmas formed by catalysts providing a net enthalpy of reaction within thermal energies of $m \cdot 27.28 \ eV$[54],

43.) the formation of a chemically generated hydrogen plasma with the observation of Lyman series in the EUV that represents an energy release about 10 times that of hydrogen combustion which is greater than that of any possible known chemical reaction[55],

44.) the observation of line emission by the Institut für Niedertemperatur-Plasmaphysik e.V. with a 4° grazing incidence EUV spectrometer that was 100 times more energetic than the combustion of hydrogen[56],

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[50] Reference No. 95
[51] Reference No. 96
[52] Reference Nos. 92, 93, 97, 105
[53] Reference Nos. 13, 47, 81
[54] Reference Nos. 12, 13, 47, 81
[55] Reference Nos. 11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91
[56] Reference No. 14

45.) the excessive increase in the Lyman emission upon the addition of helium or argon catalyst to a hydrogen plasma[57],

46.) the observation of the characteristic emission from Sr^+ and Sr^{3+} that confirmed the resonant nonradiative energy transfer of $2 \cdot 27.2 \ eV$ from atomic hydrogen to Sr^+[58],

47.) the observation of anomalous plasmas formed with Sr and Ar^+ catalysts at 1% of the theoretical or prior known voltage requirement with a light output per unit power input up to 8600 times that of the control standard light source[59],

48.) the observation that the optically measured output power of gas cells for power supplied to the glow discharge increased by over two orders of magnitude depending on the presence of less than 1% partial pressure of certain catalysts in hydrogen gas or argon-hydrogen gas mixtures, and an excess thermal balance of 42 W was measured for the 97% argon and 3% hydrogen mixture versus argon plasma alone[60],

49.) the observation that glow discharge plasmas of the catalyst-hydrogen mixtures of strontium-hydrogen, helium-hydrogen, argon-hydrogen, strontium-helium-hydrogen, and strontium-argon-hydrogen showed significant Balmer α line broadening corresponding to an average hydrogen atom temperature of $25 - 45 \ eV$; whereas, plasmas of the noncatalyst-hydrogen mixtures of pure hydrogen, krypton-hydrogen, xenon-hydrogen, and magnesium-hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of $\approx 3 \ eV$[61],

50.) the observation that microwave helium-hydrogen and argon-hydrogen plasmas having catalyst Ar^+ or He^+ showed extraordinary Balmer α line broadening due to hydrogen catalysis corresponding to an average hydrogen atom temperature of $110 - 130 \ eV$ and $180 - 210 \ eV$, respectively; whereas, plasmas of pure hydrogen, neon-hydrogen, krypton-hydrogen, and xenon-hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of $\approx 3 \ eV$[62],

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[57] Reference Nos. 20, 31, 37, 43
[58] Reference Nos. 16, 52
[59] Reference Nos. 11, 16, 20, 23, 52, 72
[60] Reference No. 22
[61] Reference Nos. 16, 20, 30, 52, 72
[62] Reference Nos. 33-37, 43, 49, 60, 63-64, 69, 71, 73-74, 82, 84, 88

51.) the observation that microwave helium-hydrogen and argon-hydrogen plasmas showed average electron temperatures that were high, $30,500 \pm 5\% \, K$ and $13,700 \pm 5\% \, K$, respectively; whereas, the corresponding temperatures of helium and argon alone were only $7400 \pm 5\% \, K$ and $5700 \pm 5\% \, K$, respectively[63],

52.) the observation of significant Balmer α line broadening of 17, 9, 11, 14, *and* 24 eV from rt-plasmas of incandescently heated hydrogen with K^+ / K^+, Rb^+, cesium, strontium, and strontium with Ar^+ catalysts, respectively, wherein the results could not be explained by Stark or thermal broadening or electric field acceleration of charged species since the measured field of the incandescent heater was extremely weak, 1 V/cm, corresponding to a broadening of much less than 1 eV[64],

53.) calorimetric measurement of excess power of 20 mW/cc on rt-plasmas formed by heating hydrogen with K^+ / K^+ and Ar^+ as catalysts[65],

54.) the observation of rt-plasmas formed with strontium and argon at 1% of the theoretical or prior known voltage requirement with a light output per unit power input up to 8600 times that of the control standard light source as well as an excess power of 20 mW/cm from rt-plasmas formed by Ar^+ as the catalyst in an incandescent-filament cell[66],

55.) the Calvet calorimetry measurement of an energy balance of over $-151,000 \, kJ/mole \, H_2$ with the addition of 3% hydrogen to a plasma of argon having the catalyst Ar^+ compared to the enthalpy of combustion of hydrogen of $-241.8 \, kJ/mole \, H_2$; whereas, under identical conditions no change in the Calvet voltage was observed when hydrogen was added to a plasma of noncatalyst xenon[67],

56.) the observation that the power output exceeded the power supplied to hydrogen glow discharge plasmas by 35-184 W depending on the presence of catalysts from helium or

[63] Reference Nos. 34-37, 43, 49, 63, 67, 73
[64] Reference Nos. 39, 42, 46, 51-52, 54-55, 57, 72, 81, 89, 91
[65] Reference Nos. 39, 81, 89
[66] Reference No. 72
[67] Reference No. 31

argon and less than 1% partial pressure of strontium metal in noble gas-hydrogen mixtures; whereas, the chemically similar noncatalyst krypton had no effect on the power balance[68],

57.) the observation that with the addition of 3% flowing hydrogen to an argon microwave plasma with a constant input power of 40 W, the gas temperature increased from 400°C to over 750°C; whereas, the 400°C temperature of a xenon plasma run under identical conditions was essentially unchanged with the addition of hydrogen[69],

58.) observations of power such as that where the addition of 10% hydrogen to a helium microwave plasma maintained with a constant microwave input power of 40 W, the thermal output power was measured to be at least 280 W corresponding to a reactor temperature rise from room temperature to 1200°C within 150 seconds, a power density of 28 MW/m^3, and an energy balance of at least $-4 \, X 10^5 \, kJ/mole \, H_2$ compared to the enthalpy of combustion of hydrogen of $-241.8 \, kJ/mole \, H_2$[70],

59.) the observation of $306 \pm 5 \, W$ of excess power generated in 45 cm^3 by a compound-hollow-cathode-glow discharge of a neon-hydrogen (99.5/0.5%) mixture corresponding to a power density of 6.8 MW/m^3 and an energy balance of at least $-1 \, X 10^6 \, kJ/mole \, H_2$ compared to the enthalpy of combustion of hydrogen of $-241.8 \, kJ/mole \, H_2$[71],

60.) the observation that for an input of 37.7 W, the total plasma power of the neon-hydrogen plasma measured by water bath calorimetry was 60.7 W corresponding to 23.0 W of excess power in 3 cm^3[72],

61.) the observation of intense He^+ emission and a total plasma power of a helium-hydrogen plasma measured by water bath calorimetry of 30.0 W for an input of 8.1 W, corresponding to 21.9 W of excess power in 3 cm^3 wherein the excess power density and energy balance were high, 7.3 W/cm^3 and $-2.9 \, X 10^4 \, kJ/mole \, H_2$, respectively[73],

[68] Reference No. 30
[69] Reference No. 43
[70] Reference Nos. 34, 35
[71] Reference Nos. 50, 78
[72] Reference No. 76
[73] Reference Nos. 36, 63, 71, 73

62.) in the comparison of helium-hydrogen plasmas sources, the observation that i.) with an input power of 24.8± 1 W, the total plasma power of the Evenson microwave helium-hydrogen plasma measured by water bath calorimetry was 49.1 ± 1 W corresponding to 24.3 ± 1 W of excess power in 3 cm^3 corresponding to a high excess power density and energy balance of 8.1 W/cm^3 and over $-3 X 10^4$ $kJ/mole$ H_2, respectively, ii.) with an input of 500 W, a total power of 623 W was generated in a 45 cm^3 compound-hollow-cathode-glow discharge, iii.) less than 10% excess power was observed from inductively coupled RF helium-hydrogen plasmas, and iv.) no measurable heat was observed from MKS/Astex microwave helium-hydrogen plasmas that corresponded to the absence of H Balmer line broadening[74],

63.) the observation of energy balances of helium-hydrogen microwave plasmas of over 100 times the combustion of hydrogen and power densities greater than 10 W/cm^3 measured by water bath calorimetry[75],

64.) at the load matching condition of 600 Ω, the direct plasmadynamic conversion (PDC) of open circuit voltages of 11.5 V and ~200 mW of electrical power with a 0.125 in diameter by 3/4 in long plasmadynamic electrode and a 140 G applied field corresponding to an extracted power density of ~1.61 W/cm^3 and an efficiency of ~18.8%[76],

65.) at the load matching condition of 250 Ω, the direct plasmadynamic conversion (PDC) of open circuit voltages of 21.8 V and 1.87 W of electrical power with a 0.125 in diameter by 3/4 in long plasmadynamic electrode and a 140 G applied field corresponding to an extracted power density of 3.6 W/cm^3 and an efficiency of 42%[77],

66.) the projection that the generation of electricity using magnetohydrodynamic (MHD) conversion of the plasma particle energy of small to mid-size chemically assisted microwave or glow discharge plasma (ca-plasma) power sources in the range of a few hundred Watts to several 10's of kW for microdistributed commercial applications appears feasible at 50% efficiency or better with a simple compact design[78],

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[74] Reference Nos. 84, 98, 104
[75] Reference Nos. 34-36, 50, 63, 71, 73, 76-78, 84, 92, 93, 101
[76] Reference No. 48
[77] Reference No. 56
[78] Reference No. 40

67.) the differential scanning calorimetry (DSC) measurement of minimum heats of formation of KHI by the catalytic reaction of K with atomic hydrogen and KI that were over $-2000\ kJ/mole\ H_2$ compared to the enthalpy of combustion of hydrogen of $-241.8\ kJ/mole\ H_2$[79],

68.) the isolation of novel hydrogen compounds as products of the reaction of atomic hydrogen with atoms and ions which formed an anomalous plasma as reported in the EUV studies[80],

69.) the synthesis and identification of a novel diamond-like carbon film terminated with $CH(1/p)$ (H^*DLC) comprising high binding energy hydride ions was synthesized for the first time from solid carbon by a microwave plasma reaction of a mixture of 10-30% hydrogen and 90-70% helium wherein He^+ served as a catalyst with atomic hydrogen to form the highly stable hydride ions and an energetic plasma[81],

70.) the synthesis of polycrystalline diamond films on silicon substrates without diamond seeding by a very low power microwave plasma reaction of a mixture of helium-hydrogen-methane (48.2/48.2/3.6%) wherein He^+ served as a catalyst with atomic hydrogen to form an energetic plasma with an average hydrogen atom temperature of $180-210\ eV$ versus $\approx 3\ eV$ for pure hydrogen and bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond[82],

71.) the synthesis of polycrystalline diamond films on silicon substrates without diamond seeding by a very low power microwave plasma reaction of a mixture of argon-hydrogen-methane (17.5/80/2.5%) wherein Ar^+ served as a catalyst with atomic hydrogen to form an energetic plasma with an average hydrogen atom temperature of $110-130\ eV$ versus $\approx 3\ eV$ for pure hydrogen and bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond[83],

72.) the identification of a novel highly stable surface coating $SiH(1/p)$ by time of flight secondary ion mass spectroscopy that showed SiH^+ in the positive spectrum and H^-

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[79] Reference No. 25
[80] Reference Nos. 6-10, 19, 25, 38, 41, 44-45, 60-62, 75, 81, 87, 90, 92, 93, 100, 101
[81] Reference No. 60
[82] Reference Nos. 64, 69, 88
[83] Reference Nos. 82, 88

dominant in the negative spectrum and by X-ray photoelectron spectroscopy which showed that the H content of the SiH coatings was hydride ions, $H^-(1/4)$, $H^-(1/9)$, and $H^-(1/11)$ corresponding to peaks at 11, 43, and 55 eV, respectively, and showed that the surface was remarkably stable to air[84],

73.) the isolation of novel inorganic hydride compounds such as $KHKHCO_3$ and KH following each of the electrolysis and plasma electrolysis of a K_2CO_3 electrolyte which comprised high binding energy hydride ions that were stable in water with their identification by methods such as (i) ToF-SIMS on $KHKHCO_3$ which showed inorganic hydride clusters $K[KHKHCO_3]_n^+$ and a negative ToF-SIMS dominated by hydride ion, (ii) X-ray photoelectron spectroscopy which showed novel peaks corresponding to high binding energy hydride ions, and (iii) ^1H nuclear magnetic resonance spectroscopy which showed upfield shifted peaks corresponding to more diamagnetic, high-binding-energy hydride ions[85],

74.) the identification of $LiHCl$ comprising a high binding energy hydride ion by time of flight secondary ion mass spectroscopy which showed a dominant H^- in the negative ion spectrum, X-ray photoelectron spectroscopy which showed $H^-(1/4)$ as a new peak at its predicted binding energy of 11 eV, ^1H nuclear magnetic resonance spectroscopy which showed an extraordinary upfield shifted peak of -15.4 ppm corresponding to the novel hydride ion, and powder X-ray diffraction which showed novel peaks[86],

75.) the identification of novel hydride compounds by a number of analytical methods such as (i) time of flight secondary ion mass spectroscopy which showed a dominant hydride ion in the negative ion spectrum, (ii) X-ray photoelectron spectroscopy which showed novel hydride peaks and significant shifts of the core levels of the primary elements bound to the novel hydride ions, (iii) ^1H nuclear magnetic resonance spectroscopy (NMR) which showed extraordinary upfield chemical shifts compared to the NMR of the corresponding ordinary hydrides, and (iv) thermal decomposition with analysis by gas chromatography, and mass spectroscopy which identified the compounds as hydrides[87],

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[84] Reference Nos. 45, 61, 100
[85] Reference Nos. 6-7, 9, 38, 41
[86] Reference Nos. 44, 62
[87] Reference Nos. 6-10, 19, 25, 38, 41, 44-45, 60-62, 75, 81, 87, 90, 92, 93, 100

76.) the NMR identification of novel hydride compounds MH^*X wherein M is the alkali or alkaline earth metal, X, is a halide, and H^* comprises a novel high binding energy hydride ion identified by a large distinct upfield resonance[88],

77.) the replication of the NMR results of the identification of novel hydride compounds by large distinct upfield resonances at Spectral Data Services, University of Massachusetts Amherst, University of Delaware, Grace Davison, and National Research Council of Canada[89],

78.) the NMR identification of novel hydride compounds MH^* and MH_2^* wherein M is the alkali or alkaline earth metal and H^* comprises a novel high binding energy hydride ion identified by a large distinct upfield resonance that proves the hydride ion is different from the hydride ion of the corresponding known compound of the same composition[90],

79.) the observation that the ^1H MAS NMR spectrum of novel compound KH^*Cl relative to external tetramethylsilane (TMS) showed a large distinct upfield resonance at -4.4 corresponding to an absolute resonance shift of -35.9 ppm that matched the theoretical prediction of $p = 4$, and the novel peak of KH^*I at -1.5 ppm relative to TMS corresponding to an absolute resonance shift of -33.0 ppm matched the theoretical prediction of $p = 2$[91],

80.) the observation that the predicted catalyst reactions, position of the upfield-shifted NMR peaks, and spectroscopic data for $H^-(1/2)$ and $H^-(1/4)$ were found to be in agreement[92],

81.) the isolation of fraction-principal-quantum-level molecular hydrogen $H_2(1/p)$ gas by liquefaction using an ultrahigh-vacuum, liquid nitrogen cryotrap, and the observations of novel peaks by cryogenic gas chromatography, a higher ionization energy than H_2 by mass spectroscopy, a substantial change in the EUV emission spectrum with deuterium substitution in a region where no hydrogen emission has ever been observed, and upfield shifted NMR peaks at 0.21, 2.18 and 3.47 ppm compared to that of H_2 at 4.63 ppm[93],

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[88] Reference Nos. 10, 19, 41, 44, 62, 81
[89] Reference Nos. 19, 81
[90] Reference Nos. 19, 81
[91] Reference No. 81
[92] Reference No. 81
[93] Reference Nos. 75, 87, 90, 92, 93, 94, 101

82.) the observation of ^1H NMR singlet peaks upfield of H_2 with a predicted integer spacing of 0.64 ppm at 3.47, 3.02, 2.18, 1.25, 0.85, and 0.22 ppm identified as the consecutive series $H_2(1/2)$, $H_2(1/3)$, $H_2(1/4)$, $H_2(1/5)$, $H_2(1/6)$, and $H_2(1/7)$, respectively, and $H_2(1/10)$ at -1.8 ppm wherein $H_2(1/p)$ gas was isolated by liquefaction at liquid nitrogen temperature, by decomposition of compounds found to contain the corresponding hydride ions $H^-(1/p)$, and by permeation through a hollow nickel cathode[94].

83.) the observation of excess enthalpy from a K_2CO_3 electrolytic cell of a factor of two times that of the resistive power dissipation and ^1H NMR singlet peaks upfield of H_2 with a predicted integer spacing of 0.64 ppm at 3.49, 2.17, 1.25, 0.86, and 0.21 ppm which matched the consecutive series $H_2(1/2)$, $H_2(1/4)$, $H_2(1/5)$, $H_2(1/6)$, and $H_2(1/7)$, respectively, and a higher ionizing molecular hydrogen recorded on the electrolysis gases collected in a hollow nickel cathode[95].

Applicant again respectfully demands that the Secret Committee consider and evaluate in detail all of this record evidence, which, to date, it has largely ignored. The scientific data disclosed in this extensive body of evidence was collected and peer-reviewed with great care by a group of highly qualified scientists capable of understanding every detail of Applicant's technology. The very least the Committee can do is to also carefully evaluate that data in detail, article by article, with an open mind so that Applicant is given a full and fair opportunity to present his case. If and when the Committee finally does so, Applicant believes it will find that the evidence overwhelmingly proves the existence of lower-energy hydrogen in accordance with his disclosed invention.

If, on the other hand, the Committee should find true fault with any of that data on legitimate scientific grounds—not the kind of nitpicking Applicant has seen on theoretical grounds—it should communicate as much to afford Applicant the opportunity to respond. Such scientific give-and-take is the only way to advance the prosecution of this case.

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[94] Reference Nos. 98, 101, 103-104
[95] Reference Nos. 103-104

Unfortunately, with continued prosecution of this and BlackLight's other applications, a far different pattern has emerged. The Committee continues to set arbitrary and capricious hurdles designed to avoid considering Applicant's conclusive experimental evidence and thereby block his patents from issuing. Each time Applicant clears one of these hurdles, the Committee merely raises the bar by setting new standards.

For instance, the Committee initially alleged that Applicant's disclosed hydrogen chemistry, which forms lower-energy hydrogen, related to the controversial concepts of "perpetual motion" and "cold fusion." When Applicant exposed those allegations as utter nonsense, the Committee quickly abandoned its indefensible position, arguing instead that BlackLight's lower-energy hydrogen technology violated unidentified laws of physics. Then, to cover up its failure to identify even a single physical law that was supposedly being violated, the Committee improperly placed the burden on Applicant to do so: "in order to establish enablement, applicant bears the burden of providing the accepted scientific laws wrong or incomplete." When Applicant showed that just the opposite is true—that Applicant's novel hydrogen chemistry complies with all physical laws, even at atomic and sub-atomic levels—the Committee once again backpedaled. The Committee then advanced vague assertions that Applicant's lower-energy hydrogen violated "ideas" of modern science and, later, that his technology contradicted "beliefs" in the scientific community.

The only consistency found throughout this myriad of contrived standards is the Committee's use of each to excuse it from fairly considering and evaluating Applicant's scientific evidence that lower-energy hydrogen does indeed exist. Instead, the Committee prefers engaging in a theoretical debate to the exclusion of that evidence, pitting its favored quantum theory, with all of its far-fetched and disproved predictions, against Applicant's theory of classical quantum mechanics that correctly predicts the formation of lower-energy hydrogen.

Applicant has willingly engaged the Committee in this debate, and will continue to do so if necessary, even though the patent laws do not require that an inventor understand the precise theoretical basis for why his invention works. All the law requires is that he disclose his invention in sufficient detail to enable one of ordinary skill

in the art how to practice it. Applicant has done precisely that and the Committee has failed in its burden to show otherwise.

Of course, the debate over these competing theories can go on indefinitely without resolution, which may be the Committee's strategy. Engaging in that intellectual exercise, however, will not—indeed cannot—definitively settle the question of whether practicing Applicant's disclosed hydrogen chemistry results in the formation of lower-energy hydrogen. Like any good theoretical debate, this one can only be tested and ultimately settled by fairly analyzing the unprecedented amount of experimental evidence Applicant has submitted conclusively confirming the lower energy states of hydrogen.

Applicant has expended tens of millions of dollars amassing this experimental evidence. The least the Committee can do is properly consider it. The Committee's view, however, appears to be that, because the existence of lower-energy hydrogen is theoretically impossible—at least according to its misguided view of quantum mechanics—it need not seriously analyze any contrary evidence. Applicant is hard pressed to imagine an approach to patent examination any more arbitrary and capricious than that.

In the few isolated instances in which the Committee has addressed Applicant's evidence, it offers far-fetched reasons for dismissing it without a fair hearing, again demonstrating its arbitrary and capricious approach to examination of this case. One prominent example occurred during the February 21, 2001 Interview held in all of BlackLight's then-pending lower-energy hydrogen applications, which was led by Examiner Vasudevan Jagannathan—one of the few Committee members Applicant has been able to successfully identify. At that interview, Applicant had a brief opportunity to present some of his scientific evidence, including spectroscopic data that is extraordinarily reliable in analyzing chemical compositions. Such data amounts to a "chemical fingerprint" that cannot be seriously disputed. Despite the conclusiveness of that evidence, Examiner Jagannathan dismissed it out of hand as nothing more than "a bunch of squiggly lines."

To put the absurdity of that comment in context, the PTO rationalized its withdrawal of BlackLight's five allowed patent applications, in part, by citing a January

12, 2000 article written by Dr. Robert Park, spokesman for one of Applicant's main competitors, the American Physical Society (APS). [March 22, 2000 Decision at page 7 (Attachment G)] In that article, Dr. Park made the following startling statement:

> The energy states of atoms are studied through their atomic spectra— light emitted at very specific wavelengths when electrons make a jump from one energy level to another. <u>The exact prediction of the hydrogen spectrum was one of the first great triumphs of quantum theory; it is the platform on which our entire understanding of atomic physics is built. The theory accounts perfectly for every spectral line.</u>
>
> <u>There is no line corresponding to a "hydrino" state. Indeed there is no credible evidence at all to support Mills' claim.</u> [See Attachment J (emphasis added)]

The incredible irony here—one that cannot be easily overlooked—highlights once again the extreme arbitrary and capricious approach the Committee has taken in examining this and other BlackLight applications. There is no question that the vitriol espoused by Dr. Park in his cited *Post* article was, at least, partially responsible for the PTO's suspect withdrawal of the five allowed BlackLight applications from issue. And yet, despite the fact that the very article the PTO relies upon to deny Applicant his patents recognizes that spectroscopic data is extraordinarily reliable—indeed, the "platform on which our <u>entire</u> understanding of atomic physics is built"—the Committee nonetheless continues to cavalierly ignore or dismiss that same data when submitted by Applicant.

Out of exasperation, Applicant queried Examiner Jagannathan during the February 21 Interview as to what type and quality of evidence would convince him that lower-energy hydrogen exists. In response, the Examiner required that Applicant publicly divulge confidential information by publishing his experimental evidence in peer-reviewed scientific journals for that evidence to be considered reliable. As detailed above, Applicant has more than met this newly created "publication" standard for considering his experimental evidence by submitting over 100 scientific papers for publication, even though the PTO's rules and procedures impose no such requirement. So far, over 50 of these papers have completed and passed the peer-review process conducted by highly qualified Ph.D. referees.

Applicant's experimental evidence has been extensively peer-reviewed and published in the following esteemed journals:

Applied Physics Letters

Chemistry of Materials

Electrochimica Acta

European Journal of Physics D

Fusion Technology Journal of New Materials for Electrochemical Systems

IEEE Transactions on Plasma Science

International Journal of Hydrogen Energy

Journal of Applied Physics[96]

Journal of Material Science

Journal of Molecular Structure

Journal of Optical Materials

Journal of Plasma Physics

Journal of Physics D: Applied Physics

Journal of Quantitative Spectroscopy and Radiative Transfer

Journal of New Materials for Electrochemical Systems

New Journal of Physics

Physics Essays

Plasma Sources Science and Technology

Solar Energy Materials & Solar Cells

Thermochimica Acta

Vibrational Spectroscopy

Additionally, Applicant's experimental evidence has been submitted for peer-review and publication in the following esteemed journals:

Acta Physica Polonica A

AIAA Journal

Brazilian Journal of Physics

Canadian Journal of Physics

Central European Journal of Physics

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[96] Applicant notes that the *Journal of Applied Physics* is the very same journal cited by the Committee as credible evidence that Dr. Souw, one of its premier members, is supposedly qualified to evaluate Applicant's novel hydrogen technology. [See *infra*.]

Chemical Engineering Science

Contributions to Plasma Physics

Current Applied Physics

Europhysics Letters

Fizika A

Foundations of Science

Journal of Applied Spectroscopy

Journal of Mathematical Physics

Journal of Materials Research

Journal of Physical Chemistry A

Journal of Physical Chemistry B

Journal of Vacuum Science & Technology A

Materials Characterization

Materials Chemistry and Physics

New Journal of Chemistry

Physical Review B

Physica Scripta

Spectrochimica Acta Part B: Atomic Spectroscopy

Thin Solid Films

Vacuum

Once again, however, the Secret Committee has raised the bar to patentability by arbitrarily and capriciously ignoring this vast body of evidence that it required Applicant to submit. The Committee apparently believes that its anonymous members are better qualified than the numerous skilled PhD's who peer-reviewed and approved the contents of Applicant's articles confirming the existence of lower-energy hydrogen.

The PTO's mishandling of the experimental evidence of record in this case is but one of several improper actions that have adversely effected Applicant's patent rights. Others include:

(1) illegally withdrawing or threatening to withdraw other copending BlackLight patent applications from issue, after initially allowing all claims, under highly suspicious circumstances that suggest likely interference by BlackLight's competitors;

(2) improperly examining this application by Secret Committee, effectively denying Applicant the right to confront the persons involved in that examination, to assess their qualifications and biases, and to ascertain whether those persons include BlackLight's competitors or other improper outside influences, in breach of PTO confidentiality requirements; and

(3) refusing reasonable requests by Applicant and five U.S. Senators to divulge information relating to the events that triggered the PTO's withdrawal action, and the identity of all PTO employees and non-PTO personnel involved in examining BlackLight's applications.

These improper actions bear directly upon the prosecution of BlackLight's pending applications, yet Applicant's good faith efforts to discuss and resolve these and other outstanding issues have been either ignored or rejected out of hand. One of Applicant's overtures was communicated directly to then PTO Director James E. Rogan in a letter dated December 21, 2001, from BlackLight board member Dr. Shelby T. Brewer. Dr. Brewer received his Ph.D. in Nuclear Engineering from M.I.T. and served as Assistant Energy Secretary in the Reagan administration. [See Attachment A]

As stated in his letter, Dr. Brewer's reasons for appealing to Director Rogan were motivated not only by his fiduciary duty to protect BlackLight's interests, but also by a sincere desire to avoid unnecessary embarrassment to the PTO over these lingering issues if left unresolved. Dr. Brewer appealed for a meeting with Director Rogan in an attempt to bring some closure to this matter in a way that might mutually benefit both sides.

Despite the urgency of his plea, Dr. Brewer waited over four months before finally receiving a response to his request for a meeting. In a curt letter dated April 24, 2002, from the Director's Chief-of-Staff, Jason C. Roe, the PTO advised: "We appreciate your interest in this matter, but, unfortunately, must decline your request for a meeting due to the fact that the USPTO is not in a position to discuss the issue at the present time." [See Attachment A] The PTO's response, however, merely begs the question: if not now, when will it be in a position to have these discussions?

This negative response, while disappointing, was hardly surprising. In refusing to meet with Applicant, the PTO continues to treat prosecution of this and BlackLight's

other copending cases as an adversarial proceeding. While the PTO may believe it is justified in shrouding its untoward actions under a cloak of secrecy and remaining answerable to no one, that approach does little to preserve public confidence in the patent process. Only by openly engaging Applicant in mutually beneficial discussions of all the issues in this case can the PTO ever hope to achieve that worthy goal. Applicant therefore implores the PTO to reconsider its policies and adopt a more flexible and cooperative approach by agreeing to meet with Applicant to discuss the handling of this and other pending BlackLight applications before taking any further action.

Perhaps the PTO sees no need to modify its approach, buoyed by the Federal Circuit's June 28, 2002 Decision upholding its withdrawal action that cancelled issuance of BlackLight's allowed patent applications. *See BlackLight Power, Inc. v. Director James E. Rogan*, 63 USPQ2d1534 (Fed. Cir. June 28, 2002) [Attachment B]. The Federal Circuit ruled, among other things, that an "emergency situation" trumped the controlling regulation requiring the PTO to determine the unpatentability of one or more claims before it withdrew the '294 application from issue so that the PTO's mere "concern" over patentability provided adequate basis for the withdrawal. That Decision, aside from the fact that it is erroneous,[97] does not even begin to resolve other issues that touch on the merits of this case.

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[97] Applicant believes that the Federal Court's opinion is erroneous due, in part, to its misreading of a concurring opinion of one Justice in a 38-year-old Supreme Court case to support its holding that this supposed "emergency situation"—a finding that was not supported by the record or even argued by the PTO—justified the PTO's withdrawing BlackLight's copending '294 application from issue on February 17, 2000, after payment of the issue fee. *See BlackLight Power* at page 7 *citing Baltimore & Ohio Railroad Co. v. United States*, 386 U.S. 372, 421 (1964) (Brennan, J., concurring) (recognizing the importance of leaving the Interstate Commerce Commission (ICC) great flexibility to deal with emergency situations to avoid serious damage to the national transportation system, but finding no pressing need that justified the ICC's action). The Federal Circuit stretched that case way beyond the limits of Supreme Court precedent that requires government agencies to strictly follow statutory and regulatory guidelines.

Incredibly, at oral argument, the PTO did not even suggest that an emergency situation had forced it to withdraw this application from issue on February 17, 2000. To the contrary, PTO Solicitor John M. Whealan argued that no withdrawal—emergency or otherwise—occurred on that date and admitted that, if the Court found otherwise, his case would be seriously compromised. This was because, at that time, the PTO could not locate the patent file and admittedly could not have made a determination of unpatentability of one or more claims as required by the controlling regulation. *See* 37 C.F.R. § 1.131(b)(3); MPEP § 1308 (7th Ed., Rev. 1, Feb. 2000). To avoid an adverse ruling, Solicitor Whealan sought refuge outside the administrative record, suggesting for the first time that the PTO had used the wrong form in mistakenly notifying Applicant on February 17 that his application had been withdrawn. Then, again without evidentiary support, the Solicitor tried to convince a skeptical Court that Director

One such issue is how this alleged "emergency situation" arose in the first place, *i.e.*, how the PTO became aware of BlackLight's issued U.S. Patent No. 6,024,935 (the '935 patent) that supposedly raised "concerns" about other pending applications. That issue apparently was not important to Associate Solicitor Kevin Baer who defended the PTO's conduct by arguing to the District Court: "I would even say, Your Honor, you could imagine in our head any scenario of how we learned about it. A blimp flying over us. It doesn't matter, because what matters, Your Honor, is the decision [to withdraw] itself." [May 22, 2000 Transcript at 22 (Attachment K, Tab E)]

Judge Sullivan, however, was apparently unimpressed by those comments, noting in footnote 10 of his opinion that he was "troubled by several steps in the PTO's process" and advising the PTO to "examine its patent issuance process so that their normal operations are not compromised by such seemingly suspicious procedures." [See 109 F.Supp. 2d at 53, n.10 (See Attachment L)]

While the PTO may be unconcerned how it learned of the '935 patent, Applicant considers that information critically important. If, for instance, competitors were somehow involved in events leading to the withdrawal of BlackLight's allowed applications and, perhaps, in the subsequent prosecution of those and other applications, that information would relate directly to the credibility of the rejections entered in those cases, including this one. Applicant therefore renews his request for a full accounting of how, out of the thousands of patents the PTO issues every week, his '935 patent came to its attention, thus leading to the withdrawal of BlackLight's allowed applications.

Applicant believes that concerns over outside influences on the prosecution of his applications are fully justified. Following the PTO's withdrawal action, counsel immediately investigated the facts and circumstances surrounding that action by questioning various PTO personnel. In discussions with Director Esther Kepplinger, she admitted to counsel that the withdrawal was a reaction to perceived heat—a "firestorm" as she put it—the PTO had received from an undisclosed outside source. Director

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Kepplinger, in consultation with the Examiner, had made an unpatentability determination sometime later, after Applicant had voluntarily supplied the PTO with a copy of the application—hardly an emergency situation if it were true.

Kepplinger further indicated that the withdrawal occurred only after BlackLight's '935 patent had been brought to the attention of then-Director Q. Todd Dickinson by Gregory Aharonian, another PTO outsider well known for publicly attacking issued U.S. patents.[98]

Director Kepplinger's revelations are truly disturbing in that they describe what is essentially a newly created non-statutory reexamination procedure for opposing the issuance of patents never envisioned by Congress. Compare 35 U.S.C. §§ 301-307 (patent reexamination statutes).

Following the PTO's drastic withdrawal action, Applicant discovered other reliable information suggesting the likelihood of outside interference with BlackLight's patent applications and breaches of the PTO' s duty to maintain the confidentiality of those applications. Applicant initially learned that Dr. Peter Zimmerman, former Chief Scientist for the State Department, had published an Abstract of an upcoming speech to the American Physical Society (APS)—a BlackLight competitor—boasting that his Department and the Patent Office "have fought back with success" against BlackLight. [See Attachment K, Tab C] In conversations with BlackLight's counsel, Dr. Zimmerman admitted that he had received information concerning BlackLight's applications through e-mails from Dr. Robert Park, spokesman for the APS, who told him of a contact in the PTO referred to by Dr. Park as "Deep Throat" with access to confidential patent information. [See Attachment K, Tab C]

An APS News Online bulletin, dated September 2002, suggests that Dr. Park is maintaining his questionable PTO contacts, apparently with the agency's blessing:

APS E-Board Passes Resolution on Perpetual Motion Machines

The APS Executive Board approved a resolution at its June 2002 meeting in Annapolis, MD, affirming the fraudulent nature of claims of perpetual motion machines.

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[98] See Applicant's February 28, 2000 letter to Director Kepplinger documenting telephone and personal conversations between her and Applicant's counsel regarding improper outside influence that precipitated the withdrawal of BlackLight's five allowed applications. The PTO cited this letter in its March 22, 2000 Decision affirming its withdrawal action. [See Attachment G]

The resolution was deemed necessary because of a recent increase in patent applications for such devices. <u>Robert Park, APS Director of Public Information and author of the weekly electronic newsletter, "What's New," reported that the US Patent Office has received several patent applications for perpetual motion machines during the first six months of this year alone.</u> [Park's 2000 book, *Voodoo Science*, devoted considerable space to the phenomenon of such devices throughout history.] The text of the APS resolution follows.

The Executive Board of the American Physical Society is concerned that in this period of unprecedented scientific advance, misguided or fraudulent claims of perpetual motion machines and other sources of unlimited free energy are proliferating. Such devices directly violate the most fundamental laws of nature, laws that have guided the scientific progress that is transforming our world.

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[Attachment Q (emphasis added)] Dr. Park's knowledge of the number of pending patent applications filed in the PTO directed to a particular subject matter—information that is supposedly kept confidential—raises additional questions as to his activities in interfering with the prosecution of U.S. patent applications.[99]

Of course, this should come as no surprise since Dr. Park has basically admitted his direct involvement in BlackLight's patent affairs, as evidenced by the September 6, 2002 issue of *What's New* he authored and published on the APS website:

The status of BlackLight Power's intellectual property is fuzzier than ever. BLP was awarded Patent 6,024,935 for "Lower-Energy Hydrogen Methods and Structures," a process for getting hydrogen atoms into a "state below the ground state". . . . You might expect these shrunken hydrogen atoms, called "hydrinos," to have a pretty special chemistry. Do they ever! Indeed, a second patent application titled "Hydride Compounds" had been assigned a number and BLP had paid the fee. Several other patents were in the works. That's when things started heading South. <u>Prompted by an outside inquiry (who would do such a thing?)</u>, the patent director became concerned that this hydrino stuff required the orbital electron to behave "contrary to the known laws of physics and chemistry."

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[99] Not coincidentally, the Committee initially attacked the operability of Applicant's invention by mischaracterizing it as a "perpetual motion machine" and, therefore, *per se* unpatentable. The Committee quickly withdrew that line of attack after Applicant showed it was completely lacking in any merit.

The Hydride Compounds application [the '294 application] was withdrawn for further review and the other patent applications were rejected. [September 6, 2002 Online Newsletter of Dr. R. Park, *What's New* (Attachment C) (emphasis added)]

Dr. Park's startling admission was confirmed two weeks later in the September 20, 2002 issue of the *Online Newsletter* published by the James Randi Educational Foundation (JREF). In it, James Randi gleefully boasted about Dr. Park's contacting the Patent Office with the express purpose of sabotaging Applicant's patent rights:

But why, hard on the heels of re-examining other questionable patents (see three weeks ago on this page), would the Patent Office have happened upon this particular one [BlackLight's withdrawn '294 application], when there are so many in this category? The secret can be inferred from Bob Park's weekly column, where we find: "Prompted by an outside inquiry (who would do such a thing?) . . ." That rascal!

The very fact that the Patent Office has paid heed to the complaints that Park, the JREF, and others have made, speaks well for rationality. Let's hope that we can look forward to many quack devices and systems being re-evaluated. Let's see a lot more of this "extraordinary action" from the Director. As for BlackLight Power, says Park, "Their long-awaited IPO may have to wait a little longer." [September 20, 2002 Online Newsletter of the JREF, *Swift* (Attachment C) (emphasis added)]

Despite all of this overwhelming incriminating evidence of improper outside interference by competitors with an administrative patent proceeding—a possible criminal offense—the PTO continues to ignore this matter.

Apparently, this is not the first time that Dr. Park, James Randi and PTO officials have been embroiled in a patent controversy such as this one involving improper interference with a patent proceeding. Less than a year before Applicant's five allowed applications were withdrawn from issue in February 2000, the PTO was caught up in another scandal of sorts involving the issuance of U.S. Patent Nos. 5,748,088 and 6,011,476, granted on a device that can identify the obscured location of living entities. Following issuance of the '088 patent, Dr. Park published in his *What's New* newsletter inaccurate, disparaging remarks, which were picked up by James Randi on his JREF website, concerning the operation and reliability of the claimed invention. [See Attachment H] An article published in *Science Magazine* during the pendency of the

'476 patent also reported on the controversy and the involvement of Sandia National Labs (SNL) in the testing of the device. [Attachment D]

SNL's involvement and the disclosure of confidential information to David Voss, the author of the *Science* article, was itself the subject of some controversy and resulted in the issuance of an internal PTO memorandum that was placed in the '476 patent file. In that memorandum, the PTO felt compelled to reiterate its policy forbidding PTO employees from making public disclosures concerning pending patent applications:

PTO MEMORANDUM FOR ALL EMPLOYEES: MEDIA CONTACT POLICY

Posted Date: 06/25/99
Removal Date: 07/06/99

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
ASSISTANT SECRETARY AND COMMISSIONER OF PATENTS AND
    TRADEMARKS
Washington, D.C. 20231

June 22, 1999

99-42

MEMORANDUM FOR All Employees

FROM: Acting Assistant Secretary of Commerce and Acting
           Commissioner of Patents and Trademarks

SUBJECT: Media Contact Policy

Since a memorandum on this subject was first issued several years ago, thousands of new employees have joined the PTO. Therefore, it is a good time to reiterate PTO policy concerning employee contact with members of the media including, but not limited to, those in print, broadcast, cable, and online publications.

All requests, including telephone and e-mail, from members of the media for interviews, tours, and appearances should be directed to the Office of Public Affairs (Richard Maulsby or Brigid Quinn). Public Affairs will then determine the appropriate Office response for such requests and arrange for all interviews and any other meetings with the media. A member of the Public Affairs staff may attend interviews and meetings.

This policy applies only to contact with the media, not to interactions with customers. Any questions about media contact should be directed to the Office of Public Affairs at 305-8341.

Additionally, MPEP section 1701 and TMEP section 1801 specify that Office personnel should not comment on the validity or enforceability of any U.S. patent or trademark registration. These sections also caution employees about answering other particular inquiries concerning U.S. patents or trademark registrations. Any questions on this policy should be directed to your supervisor or to the MPEP Editor at 305-8813 for patents or to the Office of the Assistant Commissioner for Trademarks at 308-8900. [Attachment E]

Curiously, SNL is where Dr. Park previously served as head of its Surface Physics Division, leading Applicant to wonder whether SNL, or any of its sister labs, have had any similar involvement in the examination of this and other BlackLight applications. Applicant's curiosity on this point is further heightened by the fact that Examiner Bernard Souw, a former employee with Brookhaven National Labs, is a premier member of the Secret Committee who has been engaged in the examination of BlackLight's patent applications for some time now. [See, e.g., App'n Ser. No. 09/513,768] As discussed below, Examiner Souw's activities as lead scientist for a company he owns in competition with BlackLight, while simultaneously examining BlackLight's patent applications, raises a genuine conflict of interest, thus adding further cause for concern over outside interference with Applicant's patent rights.

If, as Applicant suspects, the PTO has conferred with others having ties to the APS, like Dr. Park or Dr. Zimmerman, or to other BlackLight competitors in withdrawing or rejecting BlackLight's applications, that information would be highly relevant and thus must be disclosed. Obviously, knowing the identity and potential biases of all persons providing input or otherwise involved in rejecting BlackLight's applications, especially those with competing interests, bears directly on the credibility of those rejections. This point could not have been made more clear than the Committee's adoption of Examiner Souw's biased views in formulating its rejections in this case.

Applicant has, on numerous occasions, disclosed to PTO officials information relating to Dr. Park's undermining of BlackLight's patent rights, as relayed in Dr.

Brewer's December 21, 2001 letter to then PTO Director Rogan, only to be ignored. [Attachment A. See also, for example, January 19, 2001 Letter to Director Kepplinger (Attachment K)] As Dr. Brewer explained in his letter, BlackLight is obviously concerned, among other things, that the PTO may have once again breached its duty to maintain confidentiality of U.S. patent applications under 35 U.S.C. § 122, 18 U.S.C. § 2071, 37 C.F.R. § 1.14, and M.P.E.P. § 101. The PTO's curt statement that it is "not in a position to discuss the issue at the present time" does little to allay those concerns.

Dr. Brewer further expressed in his letter distress over the suspected compromise of Applicant's patent rights to his novel hydrogen chemistry by a group of physicists with a vested interest in maintaining federal funding for projects based on a competing scientific theory and concern that those physicists continue to exert improper influence over the prosecution of BlackLight's pending applications. Those suspicions are only fueled by continued PTO silence on these issues while it undercuts Applicant's patent rights based on statements of competitors like Dr. Park. For instance, in the March 22, 2000 Decision justifying its withdrawal of Applicant's allowed patent applications, the PTO relied, in part, on a *Washington Post* article written by Dr. Park only slightly more than a month prior to the withdrawal:

> While petitioner in the accompanying letter points to favorable testimonials from scientists and entrepreneurs regarding the "revolutionary technology" that the instant application is asserted to embody, this does not establish that either the Director, Technology Center 1700, or the Director, Special Programs Law Office, committed reversible error, nor that the Notice should be withdrawn. In contrast, mainstream newspapers have reported this same "revolutionary technology" is accompanied by controversy in the scientific community. See Baard et al., Scientists and entrepreneurs have lots of ideas about new sources of energy; some may even be practical, Wall St. J., Sept. 13, 1999, at R16; **Park, Perpetual motion; still going around, Washington Post, Jan. 12, 2000, at H3.** [March 22 Decision at 7 (Attachment G)]

Applicant is naturally skeptical that this timing was simply a coincidence. Regardless, the mere fact that the PTO would rely on any competitor to "bad-mouth" BlackLight's technology is troubling. That it relied on Dr. Park of all people, known for conducting "hatchet jobs" on new technologies that threaten federal funding for the physicists he represents, is contemptible.

The same *Washington Post* that ran Dr. Park's libelous article rebuked its less than credible author in a subsequent article confirming his reputation for engaging in what it described a "search-and-destroy mission" against inventors and scientists who seek to advance the bounds of science. [See Article dated June 25, 2000 (Attachment M)] To quote the article's exact words, "Park's anger permeates his rebuttals, which border on <u>character assassination</u>." Noting that "thoroughness is not Park's strong suit," the article goes on to suggest that his intentions may be less than honorable:

> Park's failure to gather first-hand data is unfortunate, but his selective omissions are far more serious. In at least one case, he violated basic principles of journalism and science itself by apparently <u>suppressing information that conflicts with his foregone conclusion</u>. . . . Such tactics are reminiscent of the behavior of a zealous DA who is so convinced that a suspect is guilty that he feels entitled to withhold some information from the jury.

Dr. Park's competitive motives in attacking BlackLight's novel hydrogen chemistry, and thereby undermining its patent rights, are clear, as further recognized by the *Post* article in its description of Dr. Park as "a Washington lobbyist and PR flack for the American Physical Society." The article goes on to warn of the serious effects a rush to judgment can have without first-hand review of experimental evidence:

> This is a serious matter, since even poorly documented vitriol can jeopardize a scientist's reputation and future funding if it is disseminated with the complicity of a respected organization such as the American Physical Society.

Incredibly, in rationalizing its withdrawal action, the PTO pays tribute to a "hatchet man" like Dr. Park, who represents a competitor intent on sabotaging BlackLight's patent rights, by citing his hostile statements against BlackLight. Yet, in explaining the issuance of BlackLight's '935 patent, the PTO publicly denigrates its entire examining corps, previously known for their careful study of experimental evidence in deciding whether to issue U.S. patents:

> [P]atent examiners do review [patent applications]. Unfortunately, patent examiners are swamped and sometimes things slip through. [Statement of Associate Solicitor Baer in *BlackLight Power, Inc. v. Q. Todd Dickinson*, May 22, 2000 Tr. at 7 (Attachment K, Tab A)]

[E]xaminers are under tremendous pressure to produce work, and if they're going to approve [an application], they just approve it and kind of let it out the door. [May 22, 2000 Tr. at 48 (Attachment K, Tab A)]

As Dr. Brewer pointed out in his December 21, 2001 letter to Director Rogan, the PTO, in making these outrageous public statements, undercuts the statutory presumption of validity that has attached to every issued U.S. patent for well over 50 years:

Presumption of validity; defenses

A patent shall be presumed valid. Each claim of a patent (whether in independent, dependent, or multiple dependent form) shall be presumed valid independently of the validity of other claims; dependent or multiple dependent claims shall be presumed valid even though dependent upon an invalid claim. The burden of establishing invalidity of a patent or any claim thereof shall rest on the party asserting such invalidity.

Underlying this statutory presumption is the premise of administrative regularity, which presumes that well-trained examiners with expertise in their respective fields properly carry out their examination duties by issuing only valid patents. See, e.g., American Hoist & Derrick Co. v. Sowa & Sons, Inc., 725 F.2d 1350, 1359 (Fed. Cir. 1984). This presumption was, in fact, confirmed by the capable work of Examiners Langel and Kalafut who, with over 50 years of experience between them, examined and allowed Applicant's '935 patent, along with BlackLight's withdrawn applications. [100]

As succinctly stated in Dr. Brewer's letter, Solicitor Baer's statements on behalf of the PTO should be alarming to just about everyone, with the possible exception of accused patent infringers, and most certainly do not reflect well on an agency charged with maintaining the integrity of the patent system. Applicant felt that a meeting with Director Rogan to secure a retraction of those statements would be mutually beneficial to both sides. Yet once again, inexplicably, the PTO was not, and presumably is still not, prepared to discuss this issue.

These and other unfair assaults on Applicant's patent rights leave him to ponder: What would motivate the PTO to conduct itself with such total disregard for U.S. patent

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[100] The Examiners initially rejected all claims in these cases, but after conducting five lengthy personal interviews with Applicant and carefully considering Applicant's experimental evidence, they ultimately allowed those claims.

laws and regulations governing its administrative authority just to attack this one Applicant?

Applicant's fear is that these attacks may be attributable to competitors, like Dr. Park, who are coordinating an organized smear campaign to discredit BlackLight's technology. That fear is only heightened by the PTO's hiding behind strained theoretical arguments as an excuse for refusing to fairly evaluate Applicant's experimental evidence, while using its Secret Committee to issue anonymous rejections in this and other BlackLight applications. Dr. Brewer also brought these issues to Director Rogan's attention as an agenda item for a meeting that, unfortunately, has never taken place.

Applicant has a right to know the identity and qualifications of all persons providing input to, or otherwise participating in, the examination process. This information bears directly on the credibility of the rejections that have been entered in this and other BlackLight applications. For instance, if Dr. Park or any of his physicist cronies have been consulted in denying Applicant his patent rights, it would certainly explain the arbitrary and capricious handling of the experimental evidence of record in those cases.

Particularly germane is the identity of all persons responsible for, or otherwise involved in, creating the Office Actions, Attachments, and Appendices that make up the record in this application and other BlackLight cases. To this day, the Committee has refused, without any adequate explanation, to provide this vital information to the detriment of Applicant.

Furthermore, Applicant is entitled to know which PTO officials are ultimately responsible for analyzing Applicant's scientific data evidencing the existence of lower-energy hydrogen, and which officials have the final authority to decide the fate of BlackLight's applications. The Committee's unfair refusal to divulge that information has also seriously handicapped Applicant's ability to effectively respond to and overcome the rejections of record.

For instance, Applicant has been stymied on numerous occasions in attempts to discover the basis for various positions articulated by the Committee, or the status of certain actions it has taken. Seldom are the Examiners of record, who are mere

signatories to the Committee's handiwork, or their immediate supervisors, able to give any useful guidance on those subjects, either because they have no authority to do so and cannot divulge who does or, in some cases, they do not know who even has custody of the patent file so as to investigate the answer to a particular question.

Knowing who is responsible for analyzing the record evidence would also allow Applicant to assess that person's qualifications, as compared to those Ph.D. scientists who have peer reviewed the published experimental evidence confirming lower energy states of hydrogen. Equally important, by knowing who has authority to issue BlackLight's applications, Applicant can more easily ascertain and satisfy the patentability standards being applied in rejecting claims to his novel hydrogen technology.

Illustrating this last point, Applicant attempted to force the Secret Committee to set reasonable standards by which his data could be accepted as reliable proof by requesting the personal Interview that was held on February 21, 2001. Of course, to effectively determine the standards being applied against Applicant, he first had to identify the person(s) responsible for setting those standards.

Applicant, however, was only partially successful in that effort. Prior to the February 21 Interview, Applicant's counsel uncovered the identity of only one Committee member, Examiner Vasu Jagannathan, who played a role in rejecting BlackLight's applications. Incredibly, Examiner Jagannathan initially denied any such involvement, accurately noting that his name did not appear anywhere in the record. He therefore refused counsel's explicit request that he attend the upcoming Interview. Only after counsel wrote to a high-level supervisor demanding that Examiner Jagannathan attend did counsel receive confirmation that the Examiner was "directly involved in the creation of the Office Action" to be discussed at the Interview and that he would indeed attend. [See January 19, 2001 letter to Director Esther Kepplinger (Attachment K) and February 12, 2001 Letter from Director Jacqueline M. Stone (Attachment N)]

Examiner Jagannathan confirmed his direct involvement by leading the Interview discussions. The Examiner's participation afforded Applicant an opportunity to assess his qualifications to examine and evaluate the experimental evidence of record. Applicant was astonished to hear Examiner Jagannathan basically admit he was

unqualified to do so based on several of his comments. One of those comments, as discussed previously, included his characterization of Applicant's highly reliable spectroscopic data confirming lower energy states of hydrogen as a "bunch of squiggly lines."

When pressed for guidance on what standards he used to evaluate Applicant's scientific data and to decide whether to issue his patents, Examiner Jagannathan would not elaborate. Rather, he proposed a new standard requiring Applicant to submit and publish his data in peer-reviewed journal articles before he would give it serious consideration. Despite strenuous objections to this newly minted standard requiring public disclosure of confidential information, Applicant has nonetheless worked diligently to comply with it.

Over the subsequent years, Applicant has used vast resources to present experimental evidence of lower energy states of hydrogen—much of it generated by independent third parties—in over 50 peer-reviewed articles published in the prestigious scientific journals mentioned above. Despite this significant accomplishment, the Committee, true to form, has essentially ignored that published evidence.

Even more impressive, Applicant has successfully met the Committee's new "publication" standard despite attempts by another of Applicant's main detractors, Dr. Zimmerman, to undermine that effort. [See Attachment H] Applicant's discovery that Dr. Zimmerman has been contacting various journals to dissuade publication of Applicant's articles is especially alarming given that the Committee has relied on non-peer reviewed statements by him—statements that were posted to an internet bulletin board of all places and that he readily admits are biased—to reject claims in BlackLight applications.

If, as Applicant suspects, the Committee has cooperated with Dr. Zimmerman, or other such biased individuals, in denying Applicant his patent rights, while those same individuals have worked behind the scenes to undermine Applicant's compliance with the Committee's concocted publication requirement, then again, that information is highly relevant and should be disclosed without further delay. Such a scenario would be entirely consistent with the prior admission by Dr. Zimmerman that while he served

as Chief Scientist for the State Department, his Department and the PTO "fought back with success" against BlackLight. [See Attachment K, Tab C.]

Applicant is hardly surprised by his inability to break the PTO's code of silence on the suspicious handling of BlackLight's applications given that the PTO has stonewalled similar inquiries from five U.S. Senators—four of whom requested that Senator Patrick Leahy, Chairman of the Judiciary Committee overseeing the PTO, and/or Commerce Secretary Donald Evans, look into this matter. [See letters to and from Senators Max Cleland, Robert Torricelli, Jon Corzine, Ron Wyden, and Gordon Smith (Attachment O)] The PTO's continued refusal to cooperate in response to Senate inquiries suggests that, perhaps, it has something to hide.[101]

If the PTO looks to the Federal Circuit's June 28, 2002 Decision for license to continue its unfair and dilatory prosecution through secret examination, it will not find it. Indeed, Judge Newman, in rationalizing her ruling, incorrectly assumed that the PTO would fairly and expeditiously prosecute BlackLight's applications:

> Such action must of course be reasonable under the circumstances and rare in occurrence, lest the emergency become the rule. But when necessary in order to fulfill the PTO's mission, with safeguards to the interests of the applicant including fair and expeditious further examination, we agree with the district court that the action taken is a permissible implementation of the statute and regulation. [See *BlackLight Power* at pages 1537 (Attachment B) (emphasis added).]

Nothing could be further from the truth. As documented by Applicant, the PTO's prosecution of BlackLight's applications has been nothing short of hostile and its attempt to hide the mistreatment of Applicant behind the authority of a Secret Committee only exacerbates the unfairness of those actions. Because this untenable situation has failed to provide the safeguards to the interests of Applicant, including a fair and expeditious further examination, as contemplated by the Federal Circuit in its

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[101] In the PTO's reply to the Senators' inquiry letters, Robert L. Stoll, Administrator for External Affairs, contended that any comments in response to those inquiries would be "inappropriate" because of the then-pending appeal to the Federal Circuit in *BlackLight Power Inc. v. Dickinson*, Civ. No. 00-0422 (D.D.C). [See Attachment O] Putting aside the fact that the issues then on appeal had absolutely nothing to do with the points of inquiry, this contrived excuse has gone stale as the Federal Circuit decided that case many years ago in June 2002. [See Attachment B] By its own statements, nothing now prevents the PTO from cooperating with the U.S. Senate regarding the administrative irregularities brought to its attention.

Decision, Applicant has herein requested an equitable remedy that the PTO immediately issue all five of the withdrawn BlackLight applications that gave rise to that Decision. [See Demand for Information and Redress, *infra*.]

Applicant strongly urges the PTO to break its silence and to engage in an open and honest discussion of these issues that continue to plague the examination of BlackLight's pending applications. To this end, Applicant renews his earlier commitment, as expressed in Dr. Brewer's December 21, 2001 letter, to meet with the PTO Director and/or any other government officials, anywhere, anytime, to resolve these outstanding issues. Applicant sincerely hopes that the Director will likewise commit himself to achieving the same objective so that a fair and expeditious prosecution of all of BlackLight's applications that safeguards Applicant's interests, as envisioned by the Federal Circuit, can be achieved with mutually beneficial results.

Part of that forward movement should include a complete and proper consideration of Applicant's overwhelming experimental evidence confirming the utility and enablement of Applicant's novel hydrogen technology. In view of that evidence, Applicant submits that the rejections under 35 U.S.C. §§ 101 and 112 are misplaced and should be withdrawn, and that the present application is in condition for allowance.

Discussions Held And Agreements Reached
During The February 11, 2003 Interview

The above-mentioned problems associated with the Secret Committee's examination of this and other BlackLight applications can be summarized as follows based on its failure to:

(1) identify all persons from within and outside the Patent Office who contributed to, or were otherwise involved in, withdrawing or rejecting BlackLight's applications;

(2) identify those persons having ultimate authority to analyze the vast body of experimental evidence demonstrating the existence of lower energy states of hydrogen and, based on that analysis, for deciding whether to issue patents on Applicant's novel hydrogen technology;

(3) establish and apply consistent patentability standards and guidelines by which that patentability decision is to be made; and

(4) properly analyze the evidence of record—now published, or to be published, in over 50 peer-reviewed journal articles—that the Committee required Applicant to submit.

The Committee merely perpetuated those failures in its previous Office Actions by dismissing, without serious analysis, Applicant's submitted data evidencing lower energy states of hydrogen. Frustrated by the Committee's inaction, but still determined to get a fair and expeditious hearing, Applicant requested and received the courtesy of another personal Interview, held February 11, 2003, to present his evidence and to discern the standards by which the ultimate decision-maker would be evaluating it.[102]

To that end, Applicant repeatedly requested that Examiner Jagannathan attend the Interview, since he had led the prior Interview held February 21, 2001, and, despite attempts to keep his identity secret, he was the only person known at the time to have been directly involved in creating the substantive Office Actions of record. Specifically, Applicant sought to question Examiner Jagannathan on why he still refused to accept Applicant's scientific data evidencing lower-energy hydrogen after it had been published, or was soon to be published, in what was then over 40 (now over 50) peer-reviewed journal articles, which he himself had required. Applicant, however, never got the chance to pose that question. Without explanation, Examiner Jagannathan refused to attend the Interview, just as he had refused to attend the Interview held two years earlier—only this time, he did not show up.

Applicant also requested that Examiners Wayne Langel and Stephen Kalafut attend the Interview, since they had previously allowed the five BlackLight applications that were mysteriously withdrawn from issue and their names were the only ones appearing in the record as signers of the substantive Office Actions under consideration. Examiners Langel and Kalafut did appear for the Interview, together with their immediate supervisors, SPE's Patrick Ryan and Stanley Silverman. Examiner

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[102] Although the Interview Summary does not specifically list the serial number of all BlackLight applications as being the subject of the February 11, 2003 Interview, Examiners Langel and Kalafut agreed beforehand that the Interview would be held to address the similar rejection of claims in all assigned BlackLight cases based on an alleged lack of utility and inoperability.

William Wayner, who was assigned to one BlackLight application prior to his retirement from the PTO and who expressed an interest in attending the Interview, also appeared.

Also attending the Interview and leading the discussions on the PTO's behalf was Quality Assurance Specialist Douglas McGinty, who until that time had never been identified to Applicant as having played any role in the examination of his applications.

Attending the Interview on behalf of BlackLight Power were the inventor, Dr. Randell L. Mills, his counsel, Jeffrey S. Melcher and Jeffrey A. Simenauer, and company Director Dr. Shelby Brewer.

Also attending the Interview as an observer at Applicant's request was Ted C. Liu, Senior Legislative Assistant for Congressman David Wu, who represents the 1st District of Oregon.

During the Interview, Applicant made a sincere effort to advance the prosecution of his applications and to find common ground upon which all of these cases, once again, would be allowed to issue as patents. Applicant believed it was a worthwhile effort in light of Examiner Langel's statements on the record reaffirming his consistent view that Applicant's novel hydrogen technology is fully operable and, therefore, entitled to patent protection. The Interview was also significant in view of the following representations and agreements that resulted from the discussions between Applicant and lead-Specialist McGinty:

(1) Applicant will identify the scientific data supporting lower energy states of hydrogen generated and furnished by independent third parties;

(2) the Examiners whose signatures appear on the rejections of record, *i.e.*, Examiners Langel, Kalafut, and Wayner, have full authority to review that data and, based on their review, to issue patents as deemed appropriate; and

(3) Applicant will confer with the signatory Examiners, either by telephone or in person, to review each assigned application on a claim-by-claim basis to ensure that the scientific data presented adequately supports the scope of the claims. For those claims determined to be adequately supported by the data, a patent will issue. For any claims deemed to be inadequately supported, Applicant reserves the right to continue seeking that broader claim coverage in subsequent proceedings.

Applicant appreciated the guidance Specialist McGinty provided during the Interview for securing BlackLight's patents. Based on that guidance, Applicant presented comments in two pending applications for which Responses were due detailing the substance of discussions held at the Patent Office on February 11th and identifying the independent, third-party data per agreement (1) above, which information is reproduced below. [U.S. Serial Nos. 09/110,678 and 09/362,693]

Applicant's comments confirmed Examiner Langel's long-held view that the claims in those cases were in condition for allowance. Applicant therefore requested that Examiner Langel exercise his authority to issue a Notice to that effect per agreement (2) above so that patents could then be issued.

Following up on the Responses filed in those pending applications per agreement (3) above, Applicant arranged for an Interview with Examiner Langel to review the cases on a claim-by-claim basis to ensure that the scientific data presented adequately supported the scope of the claims in those cases. In fact, Applicant and Examiner Langel reached a tentative understanding that certain claims were adequately supported by the data and that Applicant was therefore entitled to his patents.

Unfortunately for Applicant, that understanding was short lived after Examiner Langel, "for moral and ethical reasons," agreed under the most grievous of circumstances to his removal from examining all BlackLight applications to which he was assigned. Before discussing the prejudicial ramifications of that unfortunate incident, however, Applicant presents the following recap of the discussions held during the February 11, 2003 Interview that lead to the above agreements.[103]

Just prior to the Interview, Specialist McGinty asked that Mr. Liu speak by telephone with Talis Dzenitis, a Congressional Affairs Specialist in the PTO's Legislative and International Affairs Office, to discuss his reasons for attending. Mr. Liu explained to Specialist Dzenitis that a constituent associated with BlackLight had contacted Congressman David Wu complaining of the irregular procedures the PTO has used in examining the company's pending patent applications. The procedures complained of

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[103] Much of the substance of these discussions was confirmed in e-mail correspondence between Mr. Liu and Applicant's Counsel. [See Attachment P]

included the PTO's withdrawal of the five applications approved by Examiners Langel and Kalafut for issuance as patents and the subsequent rejection of those and other BlackLight applications by an unknown group of PTO officials referred to by Applicant as a "Secret Committee."

Specialist Dzenitis represented to Mr. Liu that no such secret committee existed at the Patent Office. Applicant was surprised by that representation considering that a group of anonymous PTO officials were known to be handling BlackLight's applications and drafting the substantive Office Actions that the Examiners of record were instructed to sign.

Examiner Langel confirmed as much in an extended discussion he had with Mr. Liu and Applicant's counsel following the formal phase of the Interview. During that discussion, Examiner Langel repeated his prior denials of having authored the substantive Office Actions of record in the BlackLight applications to which he was assigned, even though those Actions bear his signature. Examiner Langel also repeated his previously expressed view that Applicant is entitled to patents on his novel hydrogen technology and that he wanted to issue those patents. Examiner Langel explained, however, that other PTO officials unknown to him having higher authority were responsible for drafting the substantive Office Actions he signed and for deciding whether to issue Applicant his patents.

The only person Examiner Langel could identify for Mr. Liu as "having something to do with the Office Actions" was Examiner Jagannathan, whose name does not appear on any Office Action. As noted above, Examiner Jagannathan kept his identity a secret from Applicant until counsel exposed his direct involvement in creating the Office Actions of record and forced him to attend the prior Interview that he led on February 21, 2001. [See January 19, 2001 letter to Director Esther Kepplinger (Attachment K) and February 12, 2001 Letter from Director Jacqueline M. Stone (Attachment N)] When the recent February 11, 2003 Interview started, it was Specialist McGinty, another previously unidentified PTO official, who led the discussion.

Following the telephone conversation with Specialist Dzenitis, in which he denied the existence of a secret committee, Mr. Liu joined the Interview already in progress. Applicant began the Interview with a general discussion of his novel hydrogen

technology and a presentation of the experimental evidence confirming its operation and utility. Specifically, Applicant explained to the PTO officials in attendance how independent laboratory studies, including those conducted by a leading Los Alamos researcher and by a NASA funded group, as well as other highly reliable scientific data, demonstrate the existence of lower energy states of hydrogen underlying his technology.

At no time during Applicant's presentation did the PTO officials analyze or otherwise address to any significant degree the merits of that data proving the existence of lower-energy hydrogen. Rather, these officials—with the exception of Examiner Langel—raised non-technical arguments, similar to those raised in the pending Office Actions, why lower-energy hydrogen could not exist and, thus, why they were justified in according the real-world data little or no weight.

The first such argument, raised by Examiner Wayner, was based on unrelated technologies that have been subjected to ridicule in the scientific community, such as perpetual motion, cold fusion, and 100-miles-per-gallon carburetors. Examiner Wayner compared those controversial technologies to BlackLight's novel hydrogen chemistry and then asked Applicant: "How is your invention any different?"

Applicant pointed out significant differences. Unlike the far-fetched inventions mentioned by Examiner Wayner, Applicant explained that his inventions have been actually reduced to practice, as demonstrated by the many working prototype energy cells developed over the past ten years and the novel chemical compounds produced by the process, which were made available to the PTO in the past and again during the Interview. In fact, Applicant invited the PTO officials to visit his laboratory in Cranbury, New Jersey and witness the operation of his energy cells for themselves, but like prior invitations, this one too was ignored.

Applicant further distinguished his claimed inventions based on the substantial body of experimental evidence that corroborates the existence of lower energy states of hydrogen. Again, none of the PTO officials who raised non-technical arguments questioning the operability of Applicant's novel hydrogen technology made any real attempt to analyze that corroborating evidence. Indeed, Examiner Wayner frankly

admitted that his background was in mechanical engineering and, therefore, he was not qualified to conduct such an analysis.

Examiner Wayner also questioned why, if BlackLight's technology was such an important discovery, the company had not yet developed a commercial device for producing energy. Applicant explained that the high cost of developing commercial products was an impediment and that, because BlackLight was not positioned to handle commercial development, it was looking to license patents on its technology to other companies for commercialization purposes.

Concerned that Examiner Wayner might be introducing yet another new patentability standard, requiring the sale of a commercial product, counsel pressed the Examiner on whether that was his intention. Examiner Wayner plainly stated it was not and, in response to a specific question from Mr. Liu, affirmed that Applicant need not prove commercial applicability to secure a patent for his invention.[104]

Applicant also became alarmed when Examiner Wayner, in referring generally to BlackLight's "detractors," invoked only the name of APS lobbyist and spokesman Dr. Robert Park as someone who disputes the existence of lower energy states of hydrogen.[105] Applicant's counsel wanted to raise issues relating to Dr. Park's "Deep Throat" contact in the Patent Office and his reputation for conducting "hatchet jobs" on new technologies that threaten his lobbying of hundreds of millions of dollars on behalf of the APS to federally fund its pet projects. [See supra.] Specialist McGinty, however, cut counsel off, refusing to discuss the matter. When Specialist McGinty suggested that

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[104] Despite these assurances, Applicant is proceeding under the assumption that the PTO is requiring proof of commercial applicability, especially in light of his discovery that the Committee now takes the position that "allowance is not an option" in BlackLight's cases. [See infra.]

[105] To Applicant's astonishment, in the Office Actions issued in Examiner Wayner's one assigned case, the Committee has continued to cite Dr. Park's biased statements against Applicant as a basis for rejecting claims in this case:

> The opinion of Robert Park set forth in the Examiner's acton of 4/14/00, paper #16. i.e. "But according to the country's leading organization of academic physicists, Mills' hydrino theory has no credibility. "There is virtually nothing that science does not know about the hydrogen atom," said Robert Park, director of the Washingtong [sic] office of the American Physical Society. "The ground state is defined as the (energy) state below which you cannot go ... the thought there is some state below the ground state is kind of humerous [sic]." [See 4/26/04 Office Action at p. 4 in U.S. App'n Ser. No. 09/181,180.]

BlackLight has a "similar agenda," noting its recent NASA contract, Applicant corrected him, explaining that BlackLight does not receive any government funding for its research. Specialist McGinty had no response and the discussion moved onto other, less controversial subjects.

Examiner Wayner raised other issues regarding the reliability of the scientific evidence presented by Applicant. That evidence included spectroscopic data, which counsel described as being equivalent to a "chemical fingerprint." Counsel further noted that Dr. Park himself, whom Examiner Wayner identified as BlackLight's chief antagonist, has proclaimed the extraordinary reliability of spectroscopic data. [See *supra*.]

Yet when Applicant tried to present this highly reliable spectroscopic data at the Interview showing the spectral lines corresponding to lower-energy hydrogen, *i.e.*, a "hydrino" state, Examiner Wayner interrupted, commenting that "spectroscopic lines are meaningless" and "don't mean a hill of beans" to him. That comment was reminiscent of a previous one by Examiner Jagannathan characterizing Applicant's spectroscopic data as "a bunch of squiggly lines." [See *supra*.]

Counsel again became concerned that BlackLight's applications were being evaluated using rather loose patentability standards. Counsel therefore requested that the PTO officials provide some guidance regarding the evidentiary requirements they were imposing on Applicant. Specialist McGinty and Examiner Wayner at first did not respond directly to Counsel's request for guidance, but rather began questioning the accuracy of the test data Applicant submitted to confirm the existence of lower energy hydrogen.

Applicant explained that the submitted test data was generated by highly qualified Ph.D. scientists, many of whom represent independent laboratories. Applicant further noted how this data had been extensively peer-reviewed in the 40-plus (now over 50) articles published, or soon to be published, in prestigious scientific journals, including the *Journal of Applied Physics*. Applicant also provided Specialist McGinty— much to his surprise—with specific data showing the lower-energy state spectral lines that were published in the prestigious spectroscopic publication, *Journal of Molecular Structure*.

Applicant was astounded by the refusal of Specialist McGinty and Examiner Wayner to accept the reliability of the scientific data appearing in these published journal articles, especially considering the PTO's routine acceptance of evidence submitted in printed publications to overcome utility rejections. See, e.g., MPEP § 2107.01 (VI) pp. 2100-33 ("An applicant can [submit evidence in response to a utility rejection] using any combination of the following: amendments to the claims, arguments or reasoning, or new evidence submitted in an affidavit or declaration under 37 CFR 1.132, or in **a printed publication**." (emphasis added)).

Counsel also reminded the PTO officials of the standard imposed by lead-Examiner Jagannathan during the previous Interview held February 21, 2001 that conditioned his consideration of evidence of lower-energy hydrogen on its publication in peer-reviewed journal articles based on the reliability of the peer-review process. Counsel then noted once again that, despite Examiner Jagannathan's failure to provide legal authority for imposing this unreasonable standard, Applicant had not only met it, but had exceeded it with over 40 (now over 50) journal articles. Having done so, counsel expressed extreme frustration with the PTO's continued refusal to seriously analyze the published scientific data based on manufactured excuses, such as this newly concocted one concerning the accuracy of Applicant's data.

Specialist McGinty raised yet another weak excuse for ignoring the published data by asking what assurances Applicant could provide that the journal articles had been actually peer reviewed! Mystified by that question, Applicant could only state what is a simple known fact: to get scientific data published in a journal article, it must first go through a <u>rigorous</u> peer-review process. Indeed, many of Applicant's articles went through numerous drafts and required further experimentation as directed by the Ph.D. scientists who peer reviewed those articles.

At that point in the Interview, Specialist McGinty admitted that, like Examiner Wayner, he was not qualified to analyze the published data. Applicant was surprised by that admission, since the Interview was being led by Specialist McGinty and had been arranged for the express purpose of presenting the experimental evidence of record.

Examiner McGinty's admission merely fueled Applicant's prior concerns that his published scientific data was not being properly considered, prompting counsel to ask

who <u>was</u> responsible for analyzing that data. Specialist McGinty replied by stating that Examiners Langel and Kalafut, the Examiners of record, had that responsibility. That too came as a surprise since Examiners Langel and Kalafut were the ones who had originally reviewed Applicant's experimental evidence in allowing the five BlackLight applications that were subsequently withdrawn from issue. Applicant, however, was relieved to learn that these two Examiners, who had over 50 years of experience between them and who were obviously qualified to analyze the published data, were being reassigned that task.

Counsel then addressed the vexing problem of constantly changing patentability standards that had been plaguing the examination process. Counsel specifically mentioned, for example, the prior Office Actions that claimed Applicant's lower-energy hydrogen technology violated known laws of physics and chemistry without specifically identifying even one such law, and then required Applicant to prove otherwise.

Counsel also cited a recent Office Action dismissing Applicant's scientific data out of hand for failing to prove the invalidity of quantum theory:

> The request for reconsideration has been entered and considered but does not overcome the rejection . . . because there is no evidence presented which would prove applicant's contention that the theory of quantum mechanics is invalid." [October 7, 2002 Advisory Action entered in U.S. Serial No. 09/110,717]

When Specialist McGinty accused Applicant of putting a "spin" on the Examiner's rejection, counsel noted that he had been reading the above quotation directly from the Office Action.

Counsel also mentioned other recent Office Actions filed in BlackLight cases that dismissed Applicant's recent submission of peer-reviewed journal articles, in accordance with the standards imposed by Examiner Jagannathan, as being merely "cumulative" when it clearly was not and even the originally submitted evidence had not been properly analyzed.

Expressing frustration over the PTO's failure to provide any consistent patentability standards to guide Applicant, counsel once again requested that Specialist McGinty provide such guidance. Specialist McGinty again raised concern over the

integrity of the experimental evidence, but indicated that he would be more receptive to that evidence if it was validated by independent third parties.[106]

Applicant explained to Specialist McGinty that much of the evidence submitted over the previous four years was, in fact, generated by independent third parties. Applicant then began citing examples of the extensive independent third-party evidence disclosed in publications previously cited to the PTO, as well as more recently generated evidence that was subsequently submitted.[107] Specialist McGinty did not respond, whereupon counsel noted that the PTO's unfounded concern that the record evidence lacked third-party validation merely demonstrated its failure to thoroughly analyze that evidence.

Further demonstrating a lack of familiarity with the record evidence, Specialist McGinty criticized Applicant's experimental evidence as a whole by referring numerous times to only high-power plasma data. Applicant repeatedly pointed out that the plasma data was but a small fraction of the submitted evidence and that it was presented primarily to provide additional support for his plasma-related applications.

Applicant noted that the vast body of other scientific data he submitted relates to a broad range of analytical studies demonstrating the existence of lower energy states of hydrogen. For example, regarding those applications relating to novel chemical compounds, Applicant pointed Specialist McGinty to the extensive spectroscopic data

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[106] Just as Specialist McGinty sought assurances at the February 11 Interview that persons involved in generating and furnishing the scientific data submitted by Applicant are independent and unbiased, Applicant deserves similar assurances that those involved in rejecting BlackLight's applications are also independent and unbiased. Despite Applicant's repeated requests for such assurances, none have been given. The genuine conflicts of interest uncovered by Applicant involving Examiner Souw and his clearly biased views against BlackLight adopted by the Committee merely underscore the importance of this highly relevant information.

[107] See R. L. Mills, B. Dhandapani, M. Nansteel, J. He, A. Voigt, "Identification of Compounds Containing Novel Hydride Ions by Nuclear Magnetic Resonance Spectroscopy", Int. J. Hydrogen Energy, Vol. 26, No. 9, (2001), pp. 965-979.
R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", J. Mol. Struct., Vol. 643, No. 1-3, (2002), pp. 43-54.
J. Phillips, R. L. Mills, X. Chen, "Water Bath Calorimetric Study of Excess Heat in 'Resonance Transfer' Plasmas", Journal of Applied Physics, submitted.
A. J. Marchese, P. M. Jansson, J. L. Schmalzel, "The BlackLight Rocket Engine", Phase I Final Report, NASA Institute for Advanced Concepts Phase I, May 1-November 30, 2002, http://www.niac.usra.edu/files/studies/final_report/pdf/752Marchese.pdf.

supporting the identification of those compounds. Specialist McGinty, however, apparently did not understand the significance of that data, stating that the NMR data confirming lower-energy hydrogen could have been due to nitrogen. Applicant had to explain that, as a matter of basic scientific knowledge, NMR data only shows protons and that no other element but hydrogen is in the data range. Applicant also explained that the NMR data confirms the presence of an internal energy source.

Knowing that highly qualified Examiners Langel and Kalafut were once again responsible for analyzing the published data was reassuring. There still remained, however, one nagging issue, namely, who had the ultimate authority to issue Applicant his patents. Counsel expressed concern that the pending applications were being examined in secret and that, without knowing who had that authority, Applicant was being unfairly denied an opportunity to present his case to the actual decision-maker.

Specialist McGinty then stated in no uncertain terms that Examiners Langel, Kalafut, and Wayner, the signers of the Office Actions under consideration, had "full authority" to examine the pending applications and to issue the patents.

Upon hearing that statement, counsel immediately turned to Examiner Langel and asked him point blank whether, after having studied the experimental evidence of record, he still believes that BlackLight's patent applications were allowable. The Examiner replied in no uncertain terms, "Yes, they're still allowable."

Counsel then asked Examiner Langel whether he was prepared to immediately allow the claims and issue Applicant his patents in those applications assigned to him, as is customary during an Interview, to which the Examiner replied, "Fine with me."

Specialist McGinty, however, expressed uneasiness over Examiner Langel's agreement to allow claims at the Interview. Specifically, he stated his concern that even if Applicant's claimed technology were found to be operable, there were still issues of novelty and nonobviousness to be addressed before a patent could be issued.

Counsel was surprised by that statement given the PTO's arguments over the prior three years that Applicant's inventions were inoperable based on an incorrect assumption that lower-energy hydrogen cannot possibly exist. Counsel pointed out the obvious contradiction in arguing that the Examiners may still need to conduct a prior art search for possible disclosure of Applicant's lower-energy hydrogen technology.

Counsel further noted the PTO's own examination guidelines requiring Examiners to evaluate the operability and utility of a claimed invention together with its novelty and nonobviousness following a complete prior art search. See MPEP § 706.[108] Counsel again turned to Examiner Langel to confirm whether that was his understanding. The Examiner replied that it was and indicated that, in fact, the first thing he did was to conduct a thorough prior art search because he thought that might be the easiest way to dispose of the applications assigned to him. Examiner Langel explained, however, that he was unable to reject the applications on prior art grounds, which was why he originally allowed them.

Counsel acknowledged Specialist McGinty's hesitance to issue Applicant patents covering his claims at the Interview and assured him that Applicant wanted to work with him to remove any lingering concerns. Counsel then specifically asked Specialist McGinty to articulate how they might proceed in trying to accomplish that mutually beneficial goal. In response, Specialist McGinty indicated that, in the next Response to any pending or subsequent Office Actions, Applicant should focus on identifying the scientific data generated by independent third-party testing, as opposed to test data generated solely by Applicant. Counsel agreed to do that.

Specialist McGinty further expressed concern over whether that scientific data, even if assumed to be reliable, was commensurate with the scope of the claims of the various applications to adequately support patentability. Counsel stated that Applicant's data did adequately support the claimed subject matter. Counsel, however, recommended reviewing the claims of each application one by one with the assigned Examiners to see if at least some agreement could be reached as to those claims that are adequately supported and for which patents can be issued. As for any remaining

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[108] MPEP § 706 provides in pertinent part:

> After the application has been read and the claimed invention understood, a prior art search for the claimed invention is made. With the results of the prior art search, including any references provided by the applicant, the patent application should be reviewed and analyzed in conjunction with the state of the prior art to determine whether the claims define a useful, novel, nonobvious, and enabled invention that has been clearly described in the specification. The goal of examination is to clearly articulate any rejection early in the prosecution process so that the applicant has the opportunity to provide evidence of patentability and otherwise reply completely at the earliest opportunity.

claims that the Examiners believe are not adequately supported by the scientific data, Applicant would be free to seek such broader claim coverage through continued prosecution.

Specialist McGinty agreed that this was a reasonable way to proceed and granted a request by counsel, Mr. Simenauer, that this agreement be memorialized in writing in an attachment to the Interview Summary Form. Mr. Simenauer offered to draft this agreement, as is common practice, and Specialist McGinty enthusiastically accepted the offer. Mr. Simenauer then drafted the following Attachment as Specialist McGinty looked on:

ATTACHMENT TO INTERVIEW SUMMARY FORM

Applicant requested that the following points discussed at the Interview held on February 11, 2003 be included as an Attachment to the Interview Summary Form.

Applicant's counsel and the Examiners in attendance at the Interview agreed to meet again at a future date, either in person or by telephone, to continue discussions regarding the patentability of Applicant's pending patent applications. Specifically, the Examiners expressed concern that Applicant's experimental evidence be commensurate with the scope of the claims. To address that concern, Applicant's counsel agreed with the Examiners to go through the patent applications claim-by-claim with the Examiners and demonstrate how the scientific data supports those claims.

For those claims that are supported by the data, the PTO agrees to issue those claims. For those claims that the PTO determines are not supported by the data, Applicant will continue to seek that broader claim coverage in subsequent proceedings. [Attachment F]

After completing the two-page handwritten Attachment, Mr. Simenauer read it out loud in the presence of Specialist McGinty and Examiner Langel so that they could confirm its accuracy and make any necessary changes. When asked by counsel whether they were satisfied with the wording of the Attachment, Specialist McGinty stated that he was, as did Examiner Langel, who then signed each of the two pages. There was absolutely no confusion as to the agreement to issue patents for those claims found to be supported by the scientific data.

Incredibly, in a transparent attempt to rewrite history, some unknown PTO official apparently instructed Examiner Langel to sign a subsequent communication mailed over two weeks later, on February 26, 2003, that included an attached "Supplement to Interview Summary" (Attachment F), which provides in pertinent part:

> The following is a supplement to the summary concerning the February 11, 2003 interview re 09/501,622, etc. . . . A two-page Interview Summary was provided by Examiner Langel. A two page "Attachment to Interview Summary Form" also was provided by Mr. Simenauer. While the Attachment may represent the applicant's understanding of the interview, two points must be clarified.
>
> First the second page of the applicant's attachment states in part: "for those claims that are supported by the data, the PTO agrees to issue those claims." The PTO made no such agreement. Instead, the PTO representatives indicated that the rejections under both 35 USC 101 and 112, 1st para., are outstanding and that evidence as to verification by credible, established, independent third parties would carry more persuasive weight.
>
> Second, QAS Douglas McGinty was not listed in the Examiner's Interview Summary. He was present during the interview with the aforementioned attendees.
>
> [signed] Wayne Langel
> Primary Examiner
> Art unit 1754

If PTO officials wanted to retract one of the key agreements reached at the Interview, they should have expressly said so, identifying who made the decision and giving reasons for the retraction. Since this was not done, Applicant has no choice but to rely on the accuracy of the contemporaneous written record.

Moreover, in view of other agreements reached at the Interview, the suggestion that there was no agreement to issue patents under the stated conditions is absurd—though hardly surprising given the sordid prosecution history of BlackLight's patent applications. Specialist McGinty plainly stated on the record that the Examiners who signed the outstanding rejections have full authority to review the data and to issue Applicant his patents. Also of record is Examiner Langel's unequivocal statement that, based on his review, he was prepared to issue those patents. To then force this same Examiner to sign a statement two weeks after the fact denying that "for those claims

that are supported by the data, the PTO agrees to issue those claims" is, frankly, embarrassing.

Other ineffective arguments, such as those made by Examiner Kalafut that "the present Examiner did not commit to any agreements during the interview," are also disappointing and, hopefully, will not be repeated. [See Advisory Action dated April 2, 2003 filed in U.S. App'n Ser. No. 08/467,911.] Applicant acknowledges that, to the best of his recollection, Examiner Kalafut, although present at the February 11 Interview, did not speak a word. As previously indicated, it was Specialist McGinty who led the Interview on behalf of the PTO and it was he who ultimately agreed to the terms under which examination of BlackLight's patent applications would proceed, which terms were expressly reduced to writing. For Examiner Kalafut, or any other Examiner assigned to one of BlackLight's applications, to now attempt to distance themselves from that agreement based on the weak assertion that they did not personally commit to it during the Interview merely illustrates yet another example of the PTO's arbitrary and capricious approach to examining these applications.

Applicant's Identification of Scientific Data Supporting Lower energy States of Hydrogen Generated and Furnished By Independent Third-Parties

In light of the controversial prosecution history of this and other pending BlackLight cases, Applicant appreciated what seemed to be Specialist McGinty's willingness to set reasonable standards and guidelines by which Applicant's patents could finally be issued. Applicant acknowledged and documented Specialist McGinty's concern over the reliability of the record evidence, which led to his requirement that Applicant identify independent third-party verification of the scientific data as noted in the PTO's Supplement to Interview Summary. With those standards and guidelines in mind, Applicant presented in two pending applications a summary of the scientific data supporting lower energy states of hydrogen generated and furnished by independent third parties, which data is reproduced below along with additional, newly submitted data.[109]

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[109] See U.S. App'n Ser. Nos. 09/110,678 and 09/362,693.

Experimental Evidence Generated by Independent Third Parties

Applicant is unaware of any statutes, rules, or case law requiring that experimental evidence submitted by an Applicant in response to a rejection by the PTO be generated by independent third parties. Despite the higher standard imposed by Specialist McGinty requiring such third-party validation of the evidence, Applicant still has met and far exceeded this standard as shown below.

Applicant provides the following alphabetical list of independent third-party laboratories and universities that conducted the experiments and generated the scientific data relied upon and discussed in the analytical studies that follow this list:

Advanced Research - Pirelli Labs, Milan, Italy

Aero Propulsion and Power Directorate, Wright Laboratory, Air Force Material Command (ASC), Wright-Patterson Air Force Base

Atomic Energy Canada Limited, Chalk River Laboratories

Brookhaven National Laboratory

Charles Evans & Associates, Sunnyvale, CA

Charles Evans East, East Windsor, NJ

Environmental Catalysis and Materials Laboratory of Virginia Polytechnic Institute

Franklin and Marshall College

Galbraith Laboratories, Inc., Knoxville, TN

Grace Davison, Columbia, MD

IC Laboratories, Amawalk, NY

Idaho National Engineering Laboratory

Institut für Niedertemperatur-Plasmaphysik e.V. (INP Greifswald, Germany)

Jobin Yvon Inc., Edison, NJ

Laboratory for Electrochemistry of Renewed Electrode-Solution Interface (LEPGER)

Liebert Corporation, Division of Emerson Corporation

Los Alamos National Laboratory

Material Testing Laboratory, Pennington, NJ

MIT Lincoln Laboratories

Moscow Power Engineering Institute

NASA Lewis

National Research Council of Canada

PacifiCorp

Pennsylvania State University Chemical Engineering Department

Perkin-Elmer Biosystems, Framingham, MA

Pirelli Labs, Milan, Italy

Ricerca, Inc., Painesville, Ohio

Rider University, Lawrenceville NJ

Rowan University Professors A. J. Marchese, P. M. Jansson, J. L. Schmalzel

Ruhr University, Bochum, Germany

Shrader Analytical & Consulting Laboratories

Spectral Data Services, Inc., Champaign, IL

S. S. W., University of Western Ontario, Canada

Surface Science Laboratories, Mountain View, CA

Thermacore, Inc., Lancaster, PA

University of Delaware, Wilmington, DE

University of Massachusetts Amherst, Amherst, MA

University of New Mexico

Westinghouse Electric Corporation

Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA

The following 47 abstracts briefly describe the analytical studies of the scientific data generated by these independent third parties (highlighted in <u>underline</u>).

Independent Test Results

51. J. Phillips, C-K Chen, R. Mills, "Evidence of catalytic Production of Hot Hydrogen in RF Generated Hydrogen/Argon Plasmas", IEEE Transactions on Plasma Science, submitted.

<u>J. Phillips, Distinguished National Laboratory Professor at Los Alamos National Laboratory and University of New Mexico</u>, performed verification studies of line broadening in catalysis plasmas. This is the third in a series of papers by our team on apparently anomalous Balmer series line broadening in hydrogen containing RF generated, low pressure (< 600 mTorr) plasmas. In this paper the selective broadening of the atomic hydrogen lines in pure H2 and Ar/H2 mixtures in a large "GEC" cell (36 cm length X 14 cm ID) was mapped as a function of position, H2/Ar ratio, time, power, and pressure. Several observations regarding the selective line broadening were particularly notable as they are unanticipated on the basis of earlier models. First, the anomalous broadening of the Balmer lines was found to exist throughout the plasma, and not just in the region between the electrodes. Second, the broadening was consistently a complex function of the operating parameters particularly gas composition (highest in pure H2) position, power and pressure. Clearly not anticipated by earlier models were the findings that under some conditions the highest concentration of "hot" (>10 eV) hydrogen was found at the entry end, and not in the high field region between the electrodes and that in other conditions, the hottest H was at the (exit) pump (also grounded electrode) end. Third, excitation and electron temperatures were less than one eV in all regions of the plasma not directly adjacent (>1mm) to the electrodes, providing additional evidence that the energy for broadening, contrary to

standard models, is not obtained from the field. Fourth, in contrast to our earlier studies of hydrogen/helium and water plasmas, we found that in some conditions 98% of the atomic hydrogen was in the "hot" state throughout the GEC cell. Virtually every operating parameter studied impacted the character of the hot H atom population, and clearly second and third order effects exist, indicating a need for experimental design. Some non-field mechanisms for generating hot hydrogen atoms, specifically those suggested by Mills' CQM model, are outlined.

50. **J. Phillips, C. K. Chen, R. Mills, "Evidence of the Production of Hot Hydrogen Atoms in RF Plasmas by Catalytic Reactions Between Hydrogen and Oxygen Species", Spectrochimica Acta Part B: Atomic Spectroscopy, submitted.**

J. Phillips, Distinguished National Laboratory Professor at Los Alamos National Laboratory and University of New Mexico, performed verification studies of line broadening in catalysis plasmas. Selective H-atom line broadening was found to be present throughout the volume (13.5 cm ID x 38 cm length) of RF generated H_2O plasmas in a GEC cell. Notably, at low pressures (ca. <0.08 Torr), a significant fraction (ca. 20%) of the atomic hydrogen was 'hot' with energies greater than 40 eV with a pressure dependence, but only a weak power dependence. The degree of broadening was virtually independent of the position studied within the GEC cell, similar to the recent finding for He/H_2 plasmas in the same GEC cell. In contrast to the atomic hydrogen lines, no broadening was observed in oxygen species lines at low pressures. Also, in 'control' Xe/H_2 plasmas run in the same cell at similar pressures and adsorbed power, no significant broadening of atomic hydrogen, Xe, or any other lines was observed. Stark broadening or acceleration of charged species due to high electric fields can not explain the results since i) the electron density was insufficient by orders of magnitude, ii) the RF field was essentially confined to the cathode fall region in contrast to the broadening that was independent of position, and iii) only the atomic hydrogen lines were broadened. Rather, all of the data is consistent with a model that claims specific, predicted, species can act catalytically through a resonant energy transfer mechanism to create 'hot' hydrogen atoms in plasmas.

49. R. L. Mills, Y. Lu, B. Dhandapani, "Spectral Identification of $H_2(1/2)$",

submitted.

Lower-energy molecular hydrogen lines were independently recorded and interpreted by Stephan Fuelling of the University of Nevada, Reno and the Nevada Terawatt Facility and provided to BlackLight. Novel emission lines with energies of $q \cdot 13.6\ eV$ where $q = 1,2,3,4,6,7,8,9,$ *or* 11 were previously observed by extreme ultraviolet (EUV) spectroscopy recorded on microwave discharges of helium with 2% hydrogen [R. L. Mills, P. Ray, J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542]. These lines matched $H(1/p)$, fractional Rydberg states of atomic hydrogen wherein $n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, ..., \frac{1}{p}$; ($p \leq 137$ is an integer) replaces the well known parameter $n =$ integer in the Rydberg equation for hydrogen excited states. Evidence supports that these states are formed by a resonant nonradiative energy transfer to He^+ acting as a catalyst; whereas, krypton, xenon, and their ions serve as controls. Two $H(1/2)$ may react to form $H_2(1/2)$ with emission of the bond energy from a resonant state within its transition state with vibration-rotational energies that are the same as those of H_2. A series of vibration-rotational bands in the 60-67 nm region, a high-energy region for which vibration-rotational spectra are ordinarily unknown, was observed from low-pressure helium-hydrogen (99/1%) microwave plasmas that matched the predicted energy spacing of the vibrational energy of H_2 about the bond energy of $H_2(1/2)$ corresponding to the reaction $2H(1/2) \rightarrow H_2(1/2)$.

48. J. Phillips, C. K. Chen, "Evidence of Energetic Reaction Between Helium and Hydrogen Species in RF Generated Plasmas", Philosophy Magazine, submitted.

A study of the line shapes of hydrogen Balmer series lines in RF generated low pressure H_2/He plasmas performed at the University of New Mexico, Department of Chemical and Nuclear Engineering produced results suggesting a catalytic process between helium and hydrogen species results in the generation of 'hot' (ca. 28 eV)

atomic hydrogen. Even far from the electrodes (ca. 15 cm) both 'cold' (<2.5 eV) and 'hot' atomic hydrogen were found in H_2/He plasmas. Line shapes, relative line areas of cold and hot atomic hydrogen (hot/cold>2.5), were very similar for areas between the electrodes and far from the electrodes for these plasmas. In contrast, in H_2/Xe only 'warm' (<5 eV) hydrogen (warm/cold<1.0) was found between the electrodes, and only cold hydrogen away from the electrodes. Earlier postulates that preferential hydrogen line broadening in plasmas results from the acceleration of ionic hydrogen in the vicinity of electrodes, and the special charge exchange characteristics of Ar/H_2^+ are clearly belied by the present results that show atomic hydrogen line shape are similar for H_2/He plasmas throughout the relatively large cylindrical (14 cm ID x 36 cm length) cavity.

47. **R. L. Mills, P. Ray, M. Nansteel, J. He, X. Chen, A. Voigt, B. Dhandapani, Luca Gamberale, "Energetic Catalyst-Hydrogen Plasma Reaction as a Potential New Energy Source", J. Phys. B: At. Mol. Opt. Phys., submitted.**

Luca Gamberale of the Advanced Research - Pirelli Labs, Milan, Italy performed verification studies as a visiting researcher at BlackLight Power, Cranbury, NJ. The prior reported results of BlackLight Power, Inc. of a chemically generated hydrogen plasma, extraordinarily broadened atomic hydrogen lines, lower-energy hydrogen molecular-ion lines, the isolation and characterization of lower-energy molecular hydrogen gas, and excess power measured by water bath calorimetry were replicated. Specifically, plasmas of certain catalysts such as Sr^+, Ar^+, and He^+ mixed with hydrogen were studied for evidence of a novel energetic reaction. A hydrogen plasma was observed to form at low temperatures (e.g. $\approx 10^3 \, K$) and an extraordinary low field strength of about 1-2 V/cm when argon and strontium were present with atomic hydrogen. RF and microwave plasmas were used to generate He^+ and Ar^+ catalysts. Extraordinarily fast H (40-50 eV) was observed by Balmer α line broadening only from plasmas having a catalyst with H. Novel emission lines with energies of $q \cdot 13.6 \, eV$ where $q = 1,2,3,4,6,7,8,9,$ or 11 were previously observed by extreme ultraviolet (EUV) spectroscopy recorded on microwave discharges of helium with 2% hydrogen [R. L. Mills, P. Ray, J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542]. These lines

matched $H(1/p)$, fractional Rydberg states of atomic hydrogen wherein

$$n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, ..., \frac{1}{p}; \ (p \le 137 \text{ is an integer) replaces the well known parameter } n = \text{integer in}$$

the Rydberg equation for hydrogen excited states. $H(1/p)$ may react with a proton and

two $H(1/p)$ may react to form $H_2(1/p)^+$ and $H_2(1/p)$, respectively, that have vibrational

and rotational energies that are p^2 times those of the species comprising uncatalyzed

atomic hydrogen. A series of over twenty peaks in the 10-65 nm region emitted from

low-pressure helium-hydrogen (90/10%) and argon-hydrogen (90/10%) microwave

plasmas matched the energy spacing of 2^2 times the transition-state vibrational energy

of H_2^+ with the series ending on the bond energy of $H_2(1/4)^+$. $H_2(1/p)$ gas was isolated

by liquefaction using an high-vacuum (10^{-6} Torr) capable, liquid nitrogen cryotrap and

was characterized by gas chromatography (GC), mass spectroscopy (MS), visible and

EUV optical emission spectroscopy (OES), and ^1H NMR of the condensable gas

dissolved in $CDCl_3$. Novel peaks were observed by cryogenic gas chromatography

performed on the condensable gas which was highly pure hydrogen by MS and had a

higher ionization energy than H_2. The observation that the EUV emission spectrum

changed with deuterium substitution in a region where no hydrogen emission has ever

been observed further supported the existence of lower-energy molecular hydrogen.

Contaminants and exotic helium-hydrogen species were eliminated as the source of the

reaction and condensed gas plasma emission spectra. Upfield shifted NMR peaks were

observed at 3.47 ppm and 2.18 ppm compared to that of H_2 at 4.63 ppm that matched

$H_2(1/2)$ and $H_2(1/4)$, respectively. Excess power was absolutely measured from the

helium-hydrogen plasma. For an input of 44.3 W, the total plasma power of the helium-

hydrogen plasma measured by water bath calorimetry was 62.9 W corresponding to

18.6 W of excess power in 3 cm^3. The excess power density and energy balance were

high, 6.2 W/cm^3 and -5×10^4 $kJ/mole \ H_2$ (240 $eV/H \ atom$), respectively.

46. **R. L. Mills, Y. Lu, J. He, M. Nansteel, P. Ray, X. Chen, A. Voigt, B. Dhandapani, "Spectral Identification of New States of Hydrogen", J. Mol. Struct., submitted.**

Novel emission lines with energies of $q \cdot 13.6 \ eV$ where $q = 1,2,3,4,6,7,8,9,11$ were previously observed by extreme ultraviolet (EUV) spectroscopy recorded on microwave discharges of helium with 2% hydrogen [R. L. Mills, P. Ray, J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542]. These lines matched $H(1/p)$, fractional Rydberg states of atomic hydrogen wherein $n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, ..., \frac{1}{p}$; ($p \leq 137$ is an integer) replaces the well known parameter $n =$ integer in the Rydberg equation for hydrogen excited states. Evidence supports that these states are formed by a resonant nonradiative energy transfer to He^+ acting as a catalyst. Ar^+ also serves as a catalyst to form $H(1/p)$; whereas, krypton, xenon, and their ions serve as controls. $H(1/p)$ may react with a proton and two $H(1/p)$ may react to form $H_2(1/p)^+$ and $H_2(1/p)$, respectively, that have vibrational and rotational energies that are p^2 times those of the species comprising uncatalyzed atomic hydrogen. A series of over twenty peaks in the 10-65 nm region emitted from low-pressure helium-hydrogen (90/10%) and argon-hydrogen (90/10%) microwave plasmas matched the energy spacing of 2^2 times the transition-state vibrational energy of H_2^+ with the series ending on the bond energy of $H_2(1/4)^+$. Rotational lines were observed in the 145-300 nm region from atmospheric pressure electron-beam excited argon-hydrogen plasmas. The unprecedented energy spacing of 4^2 times that of hydrogen established the internuclear distance as 1/4 that of H_2 and identified $H_2(1/4)$. The results were independently recorded at <u>Rutgers University</u>. $H_2(1/p)$ gas was isolated by liquefaction at liquid nitrogen temperature and by decomposition of compounds found to contain the corresponding hydride ions $H^-(1/p)$. The $H_2(1/p)$ gas was dissolved in $CDCl_3$ and characterized by ^1H NMR at <u>Rider University, Lawrenceville NJ</u>. Considering solvent effects, singlet peaks upfield of H_2 were observed with a predicted integer spacing of 0.64 ppm at 3.47, 3.02, 2.18, 1.25, 0.85, and 0.22 ppm which matched the consecutive series $H_2(1/2)$, $H_2(1/3)$, $H_2(1/4)$, $H_2(1/5)$, $H_2(1/6)$, and $H_2(1/7)$, respectively. Excess power was absolutely measured

from the helium-hydrogen plasma. For an input of 41.9 W, the total plasma power of the helium-hydrogen plasma measured by water bath calorimetry was 62.1 W corresponding to 20.2 W of excess power in 3 cm^3 plasma volume. The excess power density and energy balance were high, 6.7 W/cm^3 and $-5.4 \, X10^4 \, kJ/mole \, H_2$ (280 $eV/H \, atom$), respectively. In addition to power applications, battery and propellant reactions are proposed that may be transformational, and observed excited vibration-rotational levels of $H_2(1/4)$ could be the basis of a UV laser that could significantly advance photolithography.

45. **Dr. K.D. Keefer, Report on BlackLight Power Technology: Its Apparent Scientific Basis, State of Development and Stability for Commercialization by Liebert Corporation, (2001), and, Report on BlackLight Power Technology: Its Apparent Scientific Basis, State of Development and Stability for Commercialization, (2002).**

To separate reports disclosing the results of NMR, ToF-SIMS, XPS identification of novel hydrino hydride compounds and analysis of chemically-produced plasma by an expert hired by the Liebert Corporation, a division of the well-known and highly-respected Emerson Corporation. According to the expert's own words, he "observed demonstrations of the BlackLight Power (BLP) process and …reached the inescapable conclusion that it is based on extraordinary chemical reactions that seem to release extraordinary amounts of energy…. It is [his] professional opinion that the BLP process represents a chemical conversion of atomic hydrogen unlike any previously reported [in] the archival scientific literature." Although the expert states that he was skeptical of Applicant's theory, he admitted that the chemical and plasma data did support Applicant's fractional quantum states and that he could offer no other explanation of the data using conventional quantum theory.

44. **A. J. Marchese, P. M. Jansson, J. L. Schmalzel, "The BlackLight Rocket Engine", Phase I Final Report, NASA Institute for Advanced Concepts Phase I, May 1-November 30, 2002,**

http://www.niac.usra.edu/files/studies/final_report/pdf/752Marchese.pdf.

Rowan University Professors A. J. Marchese, P. M. Jansson, J. L. Schmalzel performed verification studies as visiting researchers at BlackLight Power, Cranbury, NJ. The prior reported results of BlackLight Power, Inc. of extraordinarily broadened atomic hydrogen lines, population inversion, lower-energy hydrogen lines, and excess power measured by water bath calorimetry were replicated. The application of the energetic hydrogen to propulsion was studied.

Specifically, the data supporting hydrinos was replicated. See

i.) BlackLight Process Theory (pp. 10-12) which gives the theoretical energy levels for hydrinos and the catalytic reaction to form hydrinos,

ii.) Unique Hydrogen Line Broadening in Low Pressure Microwave Water Plasmas (pp. 25-27, particularly Fig. 21) which shows that in the same microwave cavity driven at the same power, the temperature of the hydrogen atoms in the microwave plasma where the hydrino reaction was active was 50 times that of the control based on the spectroscopic line widths,

iii.) Inversion of the Line Intensities in Hydrogen Balmer Series (pp. 27-28, particularly Fig. 22) which shows for the first time in 40 years of intensive worldwide research that atomic hydrogen population inversion was achieved in a steady state plasma and supports the high power released from the reaction of hydrogen to form hydrinos,

iv.) Novel Vacuum Ultraviolet (VUV) Vibration Spectra of Hydrogen Mixture Plasmas (pp. 28-29, particularly Fig. 23) which shows a novel vibrational series of lines in a helium-hydrogen plasmas at energies higher than any known vibrational series and it identically matches the theoretical prediction of 2 squared times the corresponding vibration of the ordinary hydrogen species, and

v.) Water Bath Calorimetry Experiments Showing Increased Heat Generation (pp. 29-30, particularly Fig. 25) that shows that with exactly the same system and same input power, the heating of the water reservoir absolutely measured to 1% accuracy

was equivalent to 55 to 62 W with the catalyst-hydrogen mixture compared to 40 W in the control without the possibility of the reaction to form hydrinos.

43. **J. Phillips, R. L. Mills, X. Chen, "Water Bath Calorimetric Study of Excess Heat in 'Resonance Transfer' Plasmas", Journal of Applied Physics, Vol. 96, No. 6, pp. 3095-3102.**

J. Phillips, Distinguished National Laboratory Professor at Los Alamos National Laboratory and University of New Mexico, performed verification studies as a visiting researcher at BlackLight Power, Cranbury, NJ. Water bath calorimetry was used to demonstrate one more peculiar phenomenon associated with a certain class of mixed gas plasmas termed resonant transfer, or rt-plasmas. Specifically, He/H_2(10%) (500 mTorr), Ar/H_2(10%) (500 mTorr), and $H_2O(g)$ (500 mTorr and 200 mTorr) plasmas generated with an Evenson microwave cavity consistently yielded on the order of 50% more heat than non rt-plasma (controls) such as He, Kr, Kr/H_2(10%), under identical conditions of gas flow, pressure, and microwave operating conditions. The excess power density of rt-plasmas was of the order $10 \ W \cdot cm^{-3}$. In earlier studies with these same rt-plasmas it was demonstrated that other unusual features were present including dramatic broadening of the hydrogen Balmer series lines, unique vacuum ultraviolet (VUV) lines, and in the case of water plasmas, population inversion of the hydrogen excited states. Both the current results and the earlier results are completely consistent with the existence of a hitherto unknown exothermic chemical reaction, such as that predicted by Mills, occurring in rt-plasmas.

42. **R. L. Mills, P. C. Ray, R. M. Mayo, M. Nansteel, B. Dhandapani, J. Phillips, "Spectroscopic Study of Unique Line Broadening and Inversion in Low Pressure Microwave Generated Water Plasmas", J. Plasma Phys., submitted.**

J. Phillips, Distinguished National Laboratory Professor at Los Alamos National Laboratory and University of New Mexico, performed verification studies as a visiting researcher at BlackLight Power, Cranbury, NJ. It was demonstrated that low pressure (~0.2 Torr) water vapor plasmas generated in a 10 mm ID quartz tube with an Evenson

microwave cavity show at least two features which are not explained by conventional plasma models. First, significant (> 2.5 Å) hydrogen Balmer α line broadening was recorded, of constant width, up to 5 cm from the microwave coupler. Only hydrogen, and not oxygen, showed significant line broadening. This feature, observed previously in hydrogen-containing mixed gas plasmas generated with high voltage DC and RF discharges was explained by some researchers to result from acceleration of hydrogen ions near the cathode. This explanation cannot apply to the line broadening observed in the (electrodeless) microwave plasmas generated in this work, particularly at distances as great as 5 cm from the microwave coupler. Second, dramatic inversion of the line intensities of both the Lyman and Balmer series, again, at distances up to 5 cm from the coupler were observed. The dramatic line inversion suggests the existence of a hitherto unknown source of pumping of the optical power in plasmas. Finally, it is notable that other aspects of the plasma including the OH^* rotational temperature and low electron concentrations are quite typical of plasmas of this type.

41. **H. Conrads, R. Mills, Th. Wrubel, "Emission in the Deep Vacuum Ultraviolet from a Plasma Formed by Incandescently Heating Hydrogen Gas with Trace Amounts of Potassium Carbonate", Plasma Sources Science and Technology, Vol. 12, (2003), pp. 389-395.**

The generation of a hydrogen plasma with intense extreme ultraviolet and visible emission was observed at <u>Ruhr University, Bochum, Germany</u> from low pressure hydrogen gas (0.1-1 mbar) in contact with a hot tungsten filament only when the filament heated a titanium dissociator coated with K_2CO_3 above 750°C. The dissociator was electrically floated, and the electric field strength from the filament was about 1 V/cm, two orders of magnitude lower than the starting voltages measured for gas glow discharges. The emission of the H_α and H_β transitions as well as the L_α and L_β transitions were recorded and analyzed. The plasma seemed to be far from thermal equilibrium, and no conventional mechanism was found to explain the formation of a hydrogen plasma by incandescently heating hydrogen gas with the presence of trace amounts of K_2CO_3. The temporal behavior of the plasma was recorded via hydrogen

Balmer alpha line emission when all power into the cell was terminated. A two second decay of the plasma was observed after a fast decay of the electric field to zero. The plasma was found to be dependent on the chemistry of atomic hydrogen with potassium since no plasma formed with Na_2CO_3 replacing K_2CO_3 and the time constant of the emission following the removal of all of the power to the cell matched that of the cooling of the filament and the resulting shift from atomic to molecular hydrogen. Our results indicate that a novel chemical power source is present that forms the energetic hydrogen plasma. The plasma is a potential new light source.

40. R. Mills, "Observation of Extreme Ultraviolet Emission from Hydrogen-KI Plasmas Produced by a Hollow Cathode Discharge", Int. J. Hydrogen Energy, Vol. 26, No. 6, (2001), pp. 579-592.

A high voltage discharge of hydrogen with and without the presence of a source of potassium, potassium iodide, in the discharge was performed at Institut für Niedertemperatur-Plasmaphysik e.V. (INP Greifswald, Germany) with a hollow cathode. It has been reported that intense extreme ultraviolet (EUV) emission was observed at low temperatures (e.g. $< 10^3 \ K$) from atomic hydrogen and certain atomized elements or certain gaseous ions which ionize at integer multiples of the potential energy of atomic hydrogen, $27.2 \ eV$ [1, 3-5]. Two potassium ions or a potassium atom may each provide an electron ionization or transfer reaction that has a net enthalpy equal to an integer multiple of $27.2 \ eV$. The spectral lines of atomic hydrogen were intense enough to be recorded on photographic films only when KI was present. EUV lines not assignable to potassium, iodine, or hydrogen were observed at 73.0, 132.6, 513.6, 677.8, 885.9, and 1032.9 Å. The lines are assigned to transitions of atomic hydrogen to lower energy levels corresponding to lower energy hydrogen atoms called hydrino atoms and the emission from the excitation of the corresponding hydride ions formed from the hydrino atoms.

39. **R. Mills, "Temporal Behavior of Light-Emission in the Visible Spectral Range from a Ti-K$_2$CO$_3$-H-Cell', Int. J. Hydrogen Energy, Vol. 26, No. 4, (2001), pp. 327-332.**

Institut für Niedertemperatur-Plasmaphysik e.V. (INP Greifswald, Germany) reports the generation of a hydrogen plasma and extreme ultraviolet emission as recorded via the hydrogen Balmer emission in the visible range. Typically a hydrogen plasma is generated and the emission of extreme ultraviolet light from hydrogen gas is achieved via a discharge at high voltage, a high power inductively coupled plasma, or a plasma created and heated to extreme temperatures by RF coupling (e.g. $> 10^6 \ K$) with confinement provided by a toroidal magnetic field. The observed plasma formed at low temperatures (e.g. $\approx 10^3 \ K$) from atomic hydrogen generated at a tungsten filament that heated a titanium dissociator coated with potassium carbonate. The temporal behavior of the plasma was recorded via hydrogen Balmer alpha line emission when all power into the cell was terminated. A two second decay of the plasma was observed after a fast decay of the electric field to zero. The persistence of emission following the removal of all of the power to the cell indicates that a novel chemical power source is present that forms an energetic plasma in hydrogen. No unusual behavior was observed with the control sodium carbonate.

38. **R. Mills, J. Sankar, A. Voigt, J. He, P. Ray, B. Dhandapani, "Synthesis and Characterization of Diamond Films from MPCVD of an Energetic Argon-Hydrogen Plasma and Methane", Materials Science, submitted.**

Polycrystalline diamond films were synthesized on silicon substrates by a low power (~80 W) microwave plasma chemical vapor deposition (MPCVD) reaction of a mixture of argon-hydrogen-methane (17.5/80/2.5%). The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), Raman spectroscopy (Charles Evans & Associates, Sunnyvale, CA), scanning electron microscopy (SEM) (S. S. W., University of Western Ontario, Canada), and X-ray diffraction (XRD) (IC Laboratories, Amawalk, NY). It is

proposed that Ar^+ served as a catalyst with atomic hydrogen to form an energetic plasma. CH, C_2, and C_3 emissions were observed with significantly broadened H α line. The average hydrogen atom temperature of a argon-hydrogen-methane plasma was measured to be 110-$130\ eV$ versus $\approx 3\ eV$ for pure hydrogen. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the CO tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

37. **R. Mills, P. Ray, B. Dhandapani, W. Good, P. Jansson, M. Nansteel, J. He, A. Voigt, "Spectroscopic and NMR Identification of Novel Hydride Ions in Fractional Quantum Energy States Formed by an Exothermic Reaction of Atomic Hydrogen with Certain Catalysts", J. Phys. Chem. A, submitted.**

$2K^+$ to $K + K^{2+}$ and K to K^{3+} provide a reaction with a net enthalpy equal to the one and three times the potential energy of atomic hydrogen, respectively. The presence of these gaseous ions or atoms with thermally dissociated hydrogen formed a so-called resonance transfer (rt) plasma having strong VUV emission with a stationary inverted Lyman population. Significant line broadening of the Balmer α, β, and γ lines of 18 eV was observed, compared to 3 eV from a hydrogen microwave plasma. Emission from rt-plasmas occurred even when the electric field applied to the plasma was zero as recorded at <u>Institut für Niedertemperatur-Plasmaphysik e.V. (INP Greifswald, Germany</u>. The reaction was exothermic since excess power of 20 $mW \cdot cm^{-3}$ was measured by Calvet calorimetry. An energetic catalytic reaction was proposed involving a resonant energy transfer between hydrogen atoms and $2K^+$ or K to form very stable novel hydride ions $H^-(1/p)$ called hydrino hydrides having a fractional principal quantum numbers $p = 2$ and $p = 4$, respectively. Characteristic emission was observed from K^{2+} and K^{3+} that confirmed the resonant nonradiative energy transfer of $27.2\ eV$ and $3 \cdot 27.2\ eV$ from atomic hydrogen to $2K^+$ and K, respectively.

The predicted binding energy of $H^-(1/2)$ of 3.0471 eV with the fine structure was observed at 4071 Å, and its predicted bound-free hyperfine structure lines $E_{HF} = j^2 3.00213 \, X 10^{-5} + 3.0563 \, eV$ (j is an integer) matched those observed for $j = 1$ to $j = 37$ to within a 1 part per 10^4. $H^-(1/4)$ was observed spectroscopically at $110 \, nm$ corresponding to its predicted binding energy of $11.2 \, eV$. The ^1H MAS NMR spectrum (Spectral Data Services, Inc., Champaign, IL) of novel compound KH^*Cl relative to external tetramethylsilane (TMS) showed a large distinct upfield resonance at -4.4 corresponding to an absolute resonance shift of -35.9 ppm that matched the theoretical prediction of $p = 4$. A novel NMR (Grace Davison, Columbia, MD and Spectral Data Services, Inc., Champaign, IL) peak of KH^*I at -1.5 ppm relative to TMS corresponding to an absolute resonance shift of -33.0 ppm matched the theoretical prediction of $p = 2$. The predicted catalyst reactions, position of the upfield-shifted NMR peaks, and spectroscopic data for $H^-(1/2)$ and $H^-(1/4)$ were found to be in agreement.

36. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Novel Liquid-Nitrogen-Condensable Molecular Hydrogen Gas", Acta Physica Polonica A, submitted.

Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6 \, eV$ where $q = 1,2,3,4,6,7,8,9,11$ or these discrete energies less $21.2 \, eV$ corresponding to inelastic scattering of these photons by helium atoms due to excitation of $He(1s^2)$ to $He(1s^1 2p^1)$. These lines matched $H(1/p)$, fractional Rydberg states of atomic hydrogen, formed by a resonant nonradiative energy transfer to He^+. Corresponding emission due to the reaction $2H(1/2) \rightarrow H_2(1/2)$ with vibronic coupling at

$$E_{D+vib} = p^2 E_{D\,H_2} \pm \left(\frac{v^*}{3}\right) E_{vib\,H_2(v=0\rightarrow v=1)}, \quad v^* = 1,2,3...$$ was observed at the longer

wavelengths for $v^* = 2$ to $v^* = 32$ and at the shorter wavelengths for $v^* = 1$ to $v^* = 16$ where $E_{D\,H_2}$ and $E_{vib\,H_2(v=0\rightarrow v=1)}$ are the experimental bond and vibrational energies of H_2, respectively. Fractional-principal-quantum-level molecular hydrogen $H_2(1/p)$ gas was isolated by liquefaction using an ultrahigh-vacuum, liquid nitrogen cryotrap and was

characterized by gas chromatography (GC), mass spectroscopy (MS), optical emission spectroscopy (OES), and ^1H NMR (Rider University, Lawrenceville NJ) of the condensable gas dissolved in $CDCl_3$. The condensable gas was highly pure hydrogen by GC and MS and had a higher ionization energy than H_2. An upfield shifted NMR peaks were observed at 3.47 and 2.18 ppm compared to that of H_2 at 4.63 ppm. A theoretical rocketry propellant reaction is given that may be transformational.

35. **R. L. Mills, J. Sankar, A. Voigt, J. He, B. Dhandapani, "Spectroscopic Characterization of the Atomic Hydrogen Energies and Densities and Carbon Species During Helium-Hydrogen-Methane Plasma CVD Synthesis of Single Crystal Diamond Films", Chemistry of Materials, Vol. 15, (2003), pp. 1313-1321.**

Polycrystalline diamond films were synthesized on silicon substrates for the first time without diamond seeding by a very low power (38 W) microwave plasma continuous vapor deposition (MPCVD) reaction of a mixture of helium-hydrogen-methane (48.2/48.2/3.6%). The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), Raman spectroscopy (Charles Evans & Associates, Sunnyvale, CA and Jobin Yvon Inc., Edison, NJ), scanning electron microscopy (SEM) (S. S. W., University of Western Ontario, Canada and Material Testing Laboratory, Pennington, NJ), and X-ray diffraction (XRD) (IC Laboratories, Amawalk, NY). It is proposed that He^+ served as a catalyst with atomic hydrogen to form an energetic plasma. CH, C_2, and C_3 emissions were observed with significantly broadened H α, β, γ, and δ lines. The average hydrogen atom temperature of a helium-hydrogen-methane plasma was measured to be $120 - 140 \ eV$ versus $\approx 3 \ eV$ for pure hydrogen. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the CO tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

34. **R. L. Mills, J. Sankar, A. Voigt, J. He, B. Dhandapani, "Low Power MPCVD of Diamond Films on Silicon Substrates", Journal of Vacuum Science & Technology A, submitted.**

Polycrystalline diamond films were synthesized on silicon substrates for the first time without diamond seeding by a very low power (38 W) microwave plasma continuous vapor deposition (MPCVD) reaction of a mixture of 10-30% hydrogen, 90-70% helium, and 1-10% CH_4. The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), Raman spectroscopy (Charles Evans & Associates, Sunnyvale, CA), scanning electron microscopy (SEM) (S. S. W., University of Western Ontario, Canada and Material Testing Laboratory, Pennington, NJ), and X-ray diffraction (XRD) (IC Laboratories, Amawalk, NY). It is proposed that He^+ served as a catalyst with atomic hydrogen to form an energetic plasma. The average hydrogen atom temperature was measured to be $180 - 210\ eV$ versus $\approx 3\ eV$ for pure hydrogen. The electron temperature T_e for helium-hydrogen was 28,000 K compared to 6800 K for pure helium. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the CO tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

33. **R. L. Mills, A. Voigt, B. Dhandapani, J. He, "Synthesis and Spectroscopic Identification of Lithium Chloro Hydride", Materials Characterization, submitted.**

A novel inorganic hydride compound, lithium chloro hydride ($LiHCl$), which comprises a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and lithium chloride. Lithium chloro hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron

spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), ^1H nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL), and powder X-ray diffraction (IC Laboratories, Amawalk, NY). Hydride ions with increased binding energies may form many novel compounds with broad applications such as the oxidant of a high voltage battery.

32. R. L. Mills, B. Dhandapani, J. He, "Highly Stable Amorphous Silicon Hydride", Solar Energy Materials & Solar Cells, Vol. 80, No. 1, (2003), pp. 1-20.

A novel highly stable hydrogen terminated silicon coating was synthesized by microwave plasma reaction of mixture of silane, hydrogen, and helium wherein it is proposed that He^+ served as a catalyst with atomic hydrogen to form highly stable silicon hydrides. Novel silicon hydride was identified by time of flight secondary ion mass spectroscopy and X-ray photoelectron spectroscopy. The time of flight secondary ion mass spectroscopy (ToF-SIMS) identified the coatings as hydride by the large SiH^+ peak in the positive spectrum and the dominant H^- in the negative spectrum. Since hydrogen is the only element with no primary element peaks, X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA) identified the H content of the SiH coatings as comprising novel silicon hydrides due to new peaks at 11, 43, and 55 eV in the absence of corresponding peaks of any candidate element at higher binding energies. The silicon hydride surface was remarkably stable to air as shown by XPS. The highly stable amorphous silicon hydride coating may advance the production of integrated circuits and microdevices by resisting the oxygen passivation of the surface and possibly altering the dielectric constant and band gap to increase device performance.

31. R. L. Mills, J. Sankar, A. Voigt, J. He, B. Dhandapani, "Synthesis of HDLC Films from Solid Carbon", Thin Solid Films, submitted.

Diamond-like carbon (DLC) films were synthesized on silicon substrates from solid carbon by a very low power (~60 W) microwave plasma chemical vapor deposition (MPCVD) reaction of a mixture of 90-70% helium and 10-30% hydrogen. It is proposed that He^+ served as a catalyst with atomic hydrogen to form an energetic plasma. The

average hydrogen atom temperature of a helium-hydrogen plasma was measured to be $180 - 210\ eV$ versus $\approx 3\ eV$ for pure hydrogen. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of DLC. The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), and Raman spectroscopy (Charles Evans & Associates, Sunnyvale, CA). TOF-SIMS identified the coatings as hydride by the large H^+ peak in the positive spectrum and the dominant H^- in the negative spectrum. The XPS identification of the H content of the CH coatings as a novel hydride corresponding to a peak at 49 eV has implications that the mechanism of the DLC formation may also involve one or both of selective etching of graphitic carbon and the stabilization of sp^3-bonded carbon by the hydrogen catalysis product. Thus, a novel H intermediate formed by the plasma catalysis reaction may enhance the stabilization and etching role of H used in past methods.

30. **R. L. Mills, J. He, P. Ray, B. Dhandapani, X. Chen, "Synthesis and Characterization of a Highly Stable Amorphous Silicon Hydride as the Product of a Catalytic Helium-Hydrogen Plasma Reaction", Int. J. Hydrogen Energy, in press.**

A novel highly stable surface coating $SiH(1/p)$ which comprised high binding energy hydride ions was synthesized by a microwave plasma reaction of a mixture of silane, hydrogen, and helium wherein it is proposed that He^+ served as a catalyst with atomic hydrogen to form the highly stable hydride ions. Novel silicon hydride was identified by time of flight secondary ion mass spectroscopy and X-ray photoelectron spectroscopy. The time of flight secondary ion mass spectroscopy (ToF-SIMS) identified the coatings as hydride by the large SiH^+ peak in the positive spectrum and the dominant H^- in the negative spectrum. X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA) identified the H content of the SiH coatings as hydride ions, $H^-(1/4)$, $H^-(1/9)$, and $H^-(1/11)$ corresponding to peaks at 11, 43, and 55 eV, respectively. The

silicon hydride surface was remarkably stable to air as shown by XPS. The highly stable amorphous silicon hydride coating may advance the production of integrated circuits and microdevices by resisting the oxygen passivation of the surface and possibly altering the dielectric constant and band gap to increase device performance.

The plasma which formed $SiH(1/p)$ showed a number of extraordinary features. Novel emission lines with energies of $q \cdot 13.6 \ eV$ where $q = 1,2,3,4,6,7,8,9, \ or \ 11$ were previously observed by extreme ultraviolet (EUV) spectroscopy recorded on microwave discharges of helium with 2% hydrogen [R. Mills, P. Ray, "Spectral Emission of Fractional Quantum Energy Levels of Atomic Hydrogen from a Helium-Hydrogen Plasma and the Implications for Dark Matter", Int. J. Hydrogen Energy, Vol. 27, No. 3, pp. 301-322]. These lines matched $H(1/p)$, fractional Rydberg states of atomic hydrogen where p is an integer, formed by a resonant nonradiative energy transfer to He^+ acting as a catalyst. The average hydrogen atom temperature of the helium-hydrogen plasma was measured to be $180\text{-}210 \ eV$ versus $\approx 3 \ eV$ for pure hydrogen. Using water bath calorimetry, excess power was observed from the helium-hydrogen plasma compared to control krypton plasma. For example, for an input of 8.1 W, the total plasma power of the helium-hydrogen plasma measured by water bath calorimetry was 30.0 W corresponding to 21.9 W of excess power in 3 cm^3. The excess power density and energy balance were high, 7.3 W/cm^3 and $-2.9 \ X \ 10^4 \ kJ/mole \ H_2$, respectively. This catalytic plasma reaction may represent a new hydrogen energy source and a new field of hydrogen chemistry.

29. **R. L. Mills, A. Voigt, B. Dhandapani, J. He, "Synthesis and Characterization of Lithium Chloro Hydride", Int. J. Hydrogen Energy, submitted.**

A novel inorganic hydride compound lithium chloro hydride, $LiHCl$, which comprises a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and lithium chloride. Lithium chloro hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), ^1H nuclear magnetic resonance spectroscopy (Spectral

Data Services, Inc., Champaign, IL), and powder X-ray diffraction (IC Laboratories, Amawalk, NY). Hydride ions with increased binding energies may form many novel compounds with broad applications such as the oxidant of a high voltage battery.

28. **R. Mills, E. Dayalan, P. Ray, B. Dhandapani, J. He, "Highly Stable Novel Inorganic Hydrides from Aqueous Electrolysis and Plasma Electrolysis", Electrochimica Acta, Vol. 47, No. 24, (2002), pp. 3909-3926.**

After 10^4 hours of continuous aqueous electrolysis with K_2CO_3 as the electrolyte, highly stable novel inorganic hydride compounds such as $KHKHCO_3$ and KH were isolated and identified by time of flight secondary ion mass spectroscopy (ToF-SIMS) (Charles Evans East, East Windsor, NJ). The existence of novel hydride ions was determined using X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA) and solid state magic-angle spinning ^1H nuclear magnetic resonance spectroscopy (^1H MAS NMR) (Spectral Data Services, Inc., Champaign, IL). A novel ion formed by plasma electrolysis of a K_2CO_3, Rb_2CO_3, or Cs_2CO_3 electrolyte was also observed by high resolution visible spectroscopy at 407.0 nm corresponding to its predicted binding energy of $3.05\ eV$.

27. **R. Mills, B. Dhandapani, M. Nansteel, J. He, A. Voigt, "Identification of Compounds Containing Novel Hydride Ions by Nuclear Magnetic Resonance Spectroscopy", Int. J. Hydrogen Energy, Vol. 26, No. 9, Sept. (2001), pp. 965-979.**

Novel inorganic alkali and alkaline earth hydrides of the formula $MH*$, MH_2^*, and $MH*X$ wherein M is the metal, X, is a halide, and $H*$ comprises a novel high binding energy hydride ion were synthesized in a high temperature gas cell by reaction of atomic hydrogen with a catalyst and MH, MH_2, or MX corresponding to an alkali metal or alkaline earth metal compound, respectively. Novel hydride ions of the corresponding novel hydride compounds were characterized by an extraordinary upfield shifted peak observed by ^1H nuclear magnetic resonance spectroscopy. The result

were confirmed on five different instruments at five independent laboratories (Spectral Data Services, Inc., Champaign, IL, National Research Council of Canada, University of Massachusetts Amherst, Amherst, MA, University of Delaware, Wilmington, DE, and Grace Davison, Columbia, MD).

26. **R. Mills, B. Dhandapani, N. Greenig, J. He, "Synthesis and Characterization of Potassium Iodo Hydride", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1185-1203.**

A novel inorganic hydride compound KHI which comprises a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and potassium iodide. Potassium iodo hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), ^1H and ^{39}K nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL), Fourier transform infrared spectroscopy (Surface Science Laboratories, Mountain View, CA), electrospray ionization time of flight mass spectroscopy (Perkin-Elmer Biosystems, Framingham, MA), liquid chromatography/mass spectroscopy (Ricerca, Inc., Painesville, Ohio), thermal decomposition with analysis by gas chromatography, and mass spectroscopy, and elemental analysis (Galbraith Laboratories, Inc., Knoxville, TN). Hydride ions with increased binding energies may form many novel compounds with broad applications.

25. **R. Mills, "Novel Inorganic Hydride", Int. J. of Hydrogen Energy, Vol. 25, (2000), pp. 669-683.**

A novel inorganic hydride compound $KH\,KHCO_3$ which is stable in water and comprises a high binding energy hydride ion was isolated following the electrolysis of a K_2CO_3 electrolyte. Inorganic hydride clusters $K[KH\,KHCO_3]_n^+$ were identified by Time of Flight Secondary Ion Mass Spectroscopy (Charles Evans East, East Windsor, NJ). Moreover, the existence of a novel hydride ion has been determined using X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair

Laboratory, Lehigh University, Bethlehem, PA), and ^1H nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL). Hydride ions with increased binding energies may be the basis of a high voltage battery for electric vehicles.

24. **R. Mills, B. Dhandapani, M. Nansteel, J. He, T. Shannon, A. Echezuria, "Synthesis and Characterization of Novel Hydride Compounds", Int. J. of Hydrogen Energy, Vol. 26, No. 4, (2001), pp. 339-367.**

Novel inorganic alkali and alkaline earth hydrides of the formula MHX and $MHMX$ wherein M is the metal, X, is a singly negatively charged anion, and H comprises a novel high binding energy hydride ion were synthesized in a high temperature gas cell by reaction of atomic hydrogen with a catalyst and MX or MX_2 corresponding to an alkali metal or alkaline earth metal, respectively. It has been reported that intense extreme ultraviolet (EUV) emission was observed at low temperatures (e.g. $\approx 10^3 K$) from atomic hydrogen and certain atomized elements or certain gaseous ions which ionize at integer multiples of the potential energy of atomic hydrogen, $27.2 eV$ [1-5]. These atomized elements or certain gaseous ions comprised the catalyst to form MHX and $MHMX$. For example, atomic hydrogen was reacted with strontium vapor and $SrBr_2$ to form $SrHBr$. Novel hydride compounds such as $SrHBr$ were identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), ^1H nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL), and thermal decomposition with analysis by gas chromatography, and mass spectroscopy. Hydride ions with increased binding energies form novel compounds with potential broad applications such as a high voltage battery for consumer electronics and electric vehicles. In addition, these novel compositions of matter and associated technologies may have far-reaching applications in many industries including chemical, electronics, computer, military, energy, and aerospace in the form of products such as propellants, solid fuels, surface coatings, structural materials, and chemical processes.

23. R. Mills, "Highly Stable Novel Inorganic Hydrides", Journal of New Materials for Electrochemical Systems, Vol. 6, (2003), pp. 45-54.

Novel inorganic hydride compounds $KH\,KHCO_3$ and KH were isolated following the electrolysis of a K_2CO_3 electrolyte. The compounds which comprised high binding energy hydride ions were stable in water, and KH was stable at elevated temperature (600 °C). Inorganic hydride clusters $K[KH\,KHCO_3]_n^+$ were identified by positive Time of Flight Secondary Ion Mass Spectroscopy (ToF-SIMS) of $KH\,KHCO_3$ (Charles Evans East, East Windsor, NJ). The negative ToF-SIMS was dominated by hydride ion. The positive and negative ToF-SIMS of KH showed essentially K^+ and H^- only, respectively. Moreover, the existence of novel hydride ions was determined using X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), and ^1H nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL). Hydride ions with increased binding energies may be the basis of a high voltage battery for electric vehicles.

22. R. Mills, "Novel Hydrogen Compounds from a Potassium Carbonate Electrolytic Cell", Fusion Technology, Vol. 37, No. 2, March, (2000), pp. 157-182.

Novel compounds containing hydrogen in new hydride and polymeric states which demonstrate novel hydrogen chemistry have been isolated following the electrolysis of a K_2CO_3 electrolyte with the production of excess energy. Inorganic hydride clusters $K[KH\,KHCO_3]_n^+$ and hydrogen polymer ions such as OH_{23}^+ and H_{16}^- were identified by time of flight secondary ion mass spectroscopy (Charles Evans East, East Windsor, NJ). The presence of compounds containing new states of hydrogen were confirmed by X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), X-ray diffraction, Fourier transform infrared spectroscopy (Surface Science Laboratories, Mountain View, CA), Raman spectroscopy (Environmental Catalysis and Materials Laboratory of

Virginia Polytechnic Institute), and ^1H nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL).

21. **Mills, R., Good, W., "Fractional Quantum Energy Levels of Hydrogen", Fusion Technology, Vol. 28, No. 4, November, (1995), pp. 1697-1719.**

Determination of excess heat release during the electrolysis of aqueous potassium carbonate by the very accurate and reliable method of heat measurement, flow calorimetry; describes the experimental identification of hydrogen atoms in fractional quantum energy levels—hydrinos—by X-ray Photoelectron Spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA); describes the experimental identification of hydrogen atoms in fractional quantum energy levels—hydrinos—by emissions of soft X-rays from dark matter; describes the experimental identification of hydrogen molecules in fractional quantum energy levels—dihydrino molecules by high resolution magnetic sector mass spectroscopy with ionization energy determination, and gives a summary.

In summary:

Excess power and heat were observed during the electrolysis of aqueous potassium carbonate. Flow calorimetry of pulsed current electrolysis of aqueous potassium carbonate at a nickel cathode was performed in a single-cell dewar. The average power out of 24.6 watts exceeded the average input power (voltage times current) of 4.73 watts by a factor greater than 5. The total input energy (integration of voltage times current) over the entire duration of the experiment was 5.72 MJ; whereas, the total output energy was 29.8 MJ. No excess heat was observed when the electrolyte was changed from potassium carbonate to sodium carbonate. The source of heat is assigned to the electrocatalytic, exothermic reaction whereby the electrons of hydrogen atoms are induced to undergo transitions to quantized energy levels below the conventional "ground state". These lower energy states correspond to fractional quantum numbers: n = 1/2, 1/3, 1/4, ... Transitions to these lower energy states are stimulated in the presence of pairs of potassium ions (K^+/K^+ electrocatalytic couple) which provide 27.2 eV energy sinks.

The identification of the n = 1/2 hydrogen atom , H(n = 1/2) is reported. Samples of the nickel cathodes of aqueous potassium carbonate electrolytic cells and aqueous sodium carbonate electrolytic cells were analyzed by XPS (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA). A broad peak centered at 54.6 eV was present only in the cases of the potassium carbonate cells. The binding energy (in vacuum) of H(n = 1/2) is 54.4 eV. Thus, the theoretical and measured binding energies for H(n = 1/2) are in excellent agreement.

Further experimental identification of hydrinos—down to H(n = 1/8)—can be found in the alternative explanation by Mills et al. for the soft X-ray emissions of the dark interstellar medium observed by Labov and Bowyer [Labov, S., Bowyer, S., "Spectral observations of the extreme ultraviolet background", The Astrophysical Journal, 371, (1991), pp. 810-819] of the Extreme UV Center of the University of California, Berkeley. The agreement between the experimental spectrum and the energy values predicted for the proposed transitions is remarkable.

The reaction product of two H(n=1/2) atoms, the dihydrino molecule, was identified by mass spectroscopy (Shrader Analytical & Consulting Laboratories). The mass spectrum of the cryofiltered gases evolved during the electrolysis of a light water K_2CO_3 electrolyte with a nickel cathode demonstrated that the dihydrino molecule, $H_2\left(n = \frac{1}{2}\right)$, has a higher ionization energy, about 63 eV, than normal molecular hydrogen, $H_2(n = 1)$, 15.46 eV. The high resolution (0.001 AMU) magnetic sector mass spectroscopic analysis of the postcombustion gases indicated the presence of two peaks of nominal mass two-- one peak at 70 eV and one peak at 25 eV. The same analysis of molecular hydrogen indicates only one peak at 25 eV and one peak at 70 eV. In the case of the postcombustion sample at 70 eV, one peak was assigned as the hydrogen molecular ion peak, $H_2^+(n = 1)$, and one peak was assigned as the dihydrino molecular peak, $H_2^+\left(n = \frac{1}{2}\right)$ which has a slightly larger magnetic moment.

20. **Mills, R., Good, W., Shaubach, R., "Dihydrino Molecule Identification", Fusion Technology, Vol. 25, 103 (1994).**

Calorimetry of pulsed current and continuous electrolysis of aqueous potassium carbonate (K^+/K^+ electrocatalytic couple) at a nickel cathode was performed by Thermacore, Inc., Lancaster, PA. The excess power out of 41 watts exceeded the total input power given by the product of the electrolysis voltage and current by a factor greater than 8. Elemental analysis of the electrolyte and metallurgical analysis of the cathode showed no evidence of chemical reactions. The pH, specific gravity, concentration of K_2CO_3, and the elemental analysis of the electrolyte sample taken after 42 days of continuous operation were unchanged from that of the values obtained for the electrolyte sample taken before operation. Elemental analysis and scanning electron microscopy of metallurgical samples of the nickel cathode taken before operation and at day 56 of continuous operation were identical indicating that the nickel cathode had not changed chemically or physically. Scintillation counter and photographic film measurements showed that no radiation above background was detected indicating that nuclear reactions did not occur.

The "ash" of the exothermic reaction is atoms having electrons of energy below the "ground state" which are predicted to form molecules. The predicted molecules were identified by lack of reactivity with oxygen, by separation from molecular deuterium by cryofiltration, and by mass spectroscopic analysis. The combustion of the gases evolved during the electrolysis of a light water K_2CO_3 electrolyte (K^+/K^+ electrocatalytic couple) with a nickel cathode was incomplete. The mass spectroscopic analysis (Dr. David Parees of Air Products & Chemicals, Inc.) of the m/e = 2 peak of the combusted gas demonstrated that the dihydrino molecule, $H_2(n = 1/2)$, has a higher ionization energy than H_2.

Calorimetry of pulsed current and continuous electrolysis of aqueous potassium carbonate (K^+/K^+ electrocatalytic couple) at a nickel cathode was performed in single cell dewar calorimetry cells by HydroCatalysis Power Corporation. Excess power out exceeded input power by a factor greater than 16. No excess heat was observed when

the electrolyte was changed from potassium carbonate to the control sodium carbonate. The faraday efficiency was measured volumetrically to be 100%.

19. V. Noninski, Fusion Technol., Vol. 21, 163 (1992).

Dr. Noninski of the Laboratory for Electrochemistry of Renewed Electrode-Solution Interface (LEPGER) successfully reproduced the results of Mills and Kneizys [R. Mills and S. Kneizys, Fusion Technol. Vol. 20, 65 (1991)] as a visiting professor at Franklin and Marshall College. A significant increase in temperature with every watt input, compared with the calibration experiment ($\approx 50\ ^\circ C/W$ versus $\approx 30\ ^\circ C/W$), was observed during the electrolysis of potassium carbonate. This effect was not observed when sodium carbonate was electrolyzed. No trivial explanation (in terms of chemical reactions, change in heat transfer properties, etc.) of this effect were found.

18. Niedra, J., Meyers, I., Fralick, G. C., and Baldwin, R., "Replication of the Apparent Excess Heat Effect in a Light Water-Potassium Carbonate-Nickel Electrolytic Cell, NASA Technical Memorandum 107167, February, (1996). pp. 1-20.; Niedra, J., Baldwin, R., Meyers, I., NASA Presentation of Light Water Electrolytic Tests, May 15, 1994.

NASA Lewis tested a cell identical to that of Thermacore [Mills, R., Good, W., Shaubach, R., "Dihydrino Molecule Identification", Fusion Technology, Vol. 25, 103 (1994)] with the exception that it was minus the central cathode. A cell identical to the test cell with heater power only (no electrolysis) was the calibration control and the blank cell with the heater power equal to zero. The test cell was also calibrated "on the fly" by measuring the temperature relative to the blank cell at several values of heater input power of the test cell. "Replication of experiments claiming to demonstrate excess heat production in light water-Ni- K_2CO_3 electrolytic cells was found to produce an apparent excess heat of 11 W maximum, for 60 W electrical power into the cell. Power gains ranged from 1.06 to 1.68." The production of excess energy with a power gain of 1.68 would require 0% Faraday efficiency to account for the observed excess power.

17. **Technology Insights, 6540 Lusk Boulevard, Suite C-102, San Diego, CA 92121, "HydroCatalysis Technical Assessment Prepared for PacifiCorp", August 2, 1996.**

This report documents a technical assessment of a novel source of hydrogen energy advanced by HydroCatalysis Power Corporation now BlackLight Power, Inc. (BLP). The assessment was conducted as part of the due diligence performed for PacifiCorp. It was conducted by a literature search and review, site visits to BLP and collaborating organizations, and telephone interviews with others active in the general area. A description of concept is provided in Section 3. Section 4 presents an assessment of the concept background, supporting theory, laboratory prototypes, projected initial products, and economic and environmental aspects. Section 5 documents the results of telephone interviews and site visits. An overall summary and conclusions are presented in the following section.

16. **P. M. Jansson, "HydroCatalysis: A New Energy Paradigm for the 21st Century", Thesis Submitted in partial fulfillment of the requirements of the Masters of Science in Engineering Degree in the Graduate Division of Rowan University, May 1997, Thesis Advisors: Dr. J. L. Schmalzel, Dr. T. R. Chandrupatla, and Dr. A. J. Marchese, External Advisors: Dr. J. Phillips, Pennsylvania State University, Dr. R. L. Mills, BlackLight Power, Inc., W. R. Good, BlackLight Power, Inc.**

This thesis reviews the problems of worldwide energy supply, describes the current technologies that meet the energy needs of our industrial societies, summarizes the environmental impacts of those fuels and technologies and their increased use by a growing global and increasing technical economy. The work also describes and advances the technology being developed by BlackLight Power, Inc. (BLP) a scientific company located in Princeton, New Jersey. BLP's technology proports to offer commercially viable and useful heat generation via a previously unrecognized natural phenomenon - the catalytic reduction of the hydrogen atom to a lower energy state. Laboratory tests obtained as original research of this thesis as well as the review of the data of others substantiate the fact that replication of the experimental conditions which

are favorable to initiating and sustaining the new energy release process will generate controllable, reproducible, sustainable and commercial meaningful heat. For example, Jansson has determined heat production associated with hydrino formation with a Calvet calorimeter which yielded exceptional results. Specifically, the results are completely consistent with Mills hydrino formation hypothesis. Approximately 10^{-3} moles of hydrogen was admitted to a 20 cm^3 Calvet cell containing a heated platinum filament and KNO_3 powder. In the three separate trials with a platinum filament hydrogen dissociator which was varied in length of 10 cm, 20 cm, and 30 cm, a mean power of 0.581, 0.818, and 1.572 watts was observed, respectively. The closed experiments were run to completion. The energy observed was 622, 369, and 747 kJ, respectively, This is equivalent to the generation of $6.2 \times 10^8 \ J/mole$, $3.7 \times 10^8 \ J/mole$, and $7.5 \times 10^8 \ J/mole$ of hydrogen, respectively, as compared to $2.5 \times 10^5 \ J/mole$ of hydrogen anticipated for standard hydrogen combustion. Thus, the total heats generated appear to be at least 1000 times too large to be explained by conventional chemistry, but the results are completely consistent with Mills model. Convincing evidence is presented to lead to the conclusion that BLP technology has tremendous potential to achieve commercialization and become an energy paradigm for the next century. The research was also conducted as part of the due diligence performed for Atlantic Energy now Conectiv.

15. **Phillips, J., Smith, J., Kurtz, S., "Report On Calorimetric Investigations Of Gas-Phase Catalyzed Hydrino Formation" Final report for Period October-December 1996", January 1, 1997, A Confidential Report submitted to BlackLight Power, Inc. provided by BlackLight Power, Inc., Great Valley Corporate Center, 41 Great Valley Parkway, Malvern, PA 19355.**

Pennsylvania State University Chemical Engineering Department has determined heat production associated with hydrino formation with a Calvet calorimeter which yielded exceptional results. Specifically, the results are completely consistent with Mills hydrino formation hypothesis. In three separate trials, between 10 and 20 K Joules were generated at a rate of 0.5 Watts, upon admission of approximately 10^{-3} moles of

hydrogen to the 20 cm^3 Calvet cell containing a heated platinum filament and KNO_3 powder. This is equivalent to the generation of 10^7 $J/mole$ of hydrogen, as compared to 2.5×10^5 $J/mole$ of hydrogen anticipated for standard hydrogen combustion. Thus, the total heats generated appear to be 100 times too large to be explained by conventional chemistry, but the results are completely consistent with Mills model.

14. **Phillips, J., Shim, H., "Additional Calorimetric Examples of Anomalous Heat from Physical Mixtures of K/Carbon and Pd/Carbon", January 1, 1996, A Confidential Report submitted to HydroCatalysis Power Corporation provided by HydroCatalysis Power Corporation, Great Valley Corporate Center, 41 Great Valley Parkway, Malvern, PA 19355.**

Pennsylvania State University Chemical Engineering Department has determined excess heat release from flowing hydrogen in the presence of ionic hydrogen spillover catalytic material: 40% by weight potassium nitrate (KNO_3) on graphitic carbon powder with 5% by weight 1%-Pd-on-graphitic carbon (K^+/K^+ electrocatalytic couple) by the very accurate and reliable method of heat measurement, thermopile conversion of heat into an electrical output signal. Excess power and heat were observed with flowing hydrogen over the catalyst. However, no excess power was observed with flowing helium over the catalyst mixture. Rates of heat production were reproducibly observed which were higher than that expected from the conversion of all the hydrogen entering the cell to water, and the total energy observed was over four times larger than that expected if all the catalytic material in the cell were converted to the lowest energy state by "known" chemical reactions. Thus, "anomalous" heat, heat of a magnitude and duration which could not be explained by conventional chemistry, was reproducibly observed.

13. **Bradford, M. C., Phillips, J., "A Calorimetric Investigation of the Reaction of Hydrogen with Sample PSU #1", September 11, 1994, A Confidential Report submitted to HydroCatalysis Power Corporation provided by HydroCatalysis Power Corporation, Great Valley Corporate Center, 41 Great Valley Parkway, Malvern, PA 19355.**

Pennsylvania State University Chemical Engineering Department has determined excess heat release from flowing hydrogen in the presence of nickel oxide powder containing strontium niobium oxide (Nb^{3+}/Sr^{2+} electrocatalytic couple) by the very accurate and reliable method of heat measurement, thermopile conversion of heat into an electrical output signal. Excess power and heat were observed with flowing hydrogen over the catalyst which increased with increasing flow rate. However, no excess power was observed with flowing helium over the catalyst/nickel oxide mixture or flowing hydrogen over nickel oxide alone. Approximately 10 cc of nickel oxide powder containing strontium niobium oxide immediately produced 0.55 W of steady state output power at 523 K. When the gas was switched from hydrogen to helium, the power immediately dropped. The switch back to hydrogen restored the excess power output which continued to increase until the hydrogen source cylinder emptied at about the 40,000 second time point. With no hydrogen flow the output power fell to zero.

The source of heat is assigned to the electrocatalytic, exothermic reaction whereby the electrons of hydrogen atoms are induced to undergo transitions to quantized energy levels below the conventional "ground state". These lower energy states correspond to fractional quantum numbers: n = 1/2, 1/3, 1/4, ... Transitions to these lower energy states are stimulated in the presence of pairs of niobium and strontium ions (Nb^{3+}/Sr^{2+} electrocatalytic couple) which provide 27.2 eV energy sinks.

12. **Jacox, M. G., Watts, K. D., "The Search for Excess Heat in the Mills Electrolytic Cell", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, January 7, 1993.**

Idaho National Engineering Laboratory (INEL) operated a cell identical to that of Thermacore [Mills, R., Good, W., Shaubach, R., "Dihydrino Molecule Identification",

Fusion Technology, Vol. 25, 103 (1994)] except that it was minus the central cathode and that the cell was wrapped in a one-inch layer of urethane foam insulation about the cylindrical surface. The cell was operated in a pulsed power mode. A current of 10 amperes was passed through the cell for 0.2 seconds followed by 0.8 seconds of zero current for the current cycle. The cell voltage was about 2.4 volts, for an average input power of 4.8 W. The electrolysis power average was 1.84 W, and the stirrer power was measured to be 0.3 W. Thus, the total average net input power was 2.14 W. The cell was operated at various resistance heater settings, and the temperature difference between the cell and the ambient as well as the heater power were measured. The results of the excess power as a function of cell temperature with the cell operating in the pulsed power mode at 1 Hz with a cell voltage of 2.4 volts, a peak current of 10 amperes, and a duty cycle of 20 % showed that the excess power is temperature dependent for pulsed power operation, and the maximum excess power was 18 W for an input electrolysis joule heating power of 2.14 W. Thus, the ratio of excess power to input electrolysis joule heating power was 850 %. INEL scientists constructed an electrolytic cell comprising a nickel cathode, a platinized titanium anode, and a 0.57 M K_2CO_3 electrolyte. The cell design appears in Appendix 1. The cell was operated in the environmental chamber in the INEL Battery Test Laboratory at constant current, and the heat was removed by forced air convection in two cases. In the first case, the air was circulated by the environmental chamber circulatory system alone. In the second case, an additional forced air fan was directed onto the cell. The cell was equipped with a water condenser, and the water addition to the cell due to electrolysis losses was measured. The data of the forced convection heat loss calorimetry experiments during the electrolysis of a 0.57 M K_2CO_3 electrolyte with the INEL cell showed that 13 W of excess power was produced. This excess power could not be attributed to recombination of the hydrogen and oxygen as indicated by the equivalence of the calculated and measured water balance.

11. **Peterson, S., H., Evaluation of Heat Production from Light Water Electrolysis Cells of HydroCatalysis Power Corporation, Report from Westinghouse STC, 1310 Beulah Road, Pittsburgh, PA, February 25, 1994.**

Westinghouse Electric Corporation reports that excess heat was observed during the electrolysis of aqueous potassium carbonate (K^+/K^+ electrocatalytic couple) where the electrolysis of aqueous sodium carbonate served as the control. The data of the temperature of the cell minus the ambient temperature shows that when potassium carbonate replaced sodium carbonate in the same cell with the same input electrolysis power, the potassium experiment was twice as hot as the sodium carbonate experiment for the duration of the experiment, one month. The net faraday efficiency of gas evolution was experimentally measured to be unity by weighing the experiment to determine that the expected rate of water consumption was observed. The output power exceeded the total input power. The data was analyzed by HydroCatalysis Power Corporation [Mills, R., Analysis by HydroCatalysis Power Corporation of Westinghouse Report Entitled "Evaluation of Heat Production from Light Water Electrolysis Cells of HydroCatalysis Power Corporation, Report from Westinghouse STC", February 25, 1994].

10. **Haldeman, C. W., Savoye, G. W., Iseler, G. W., Clark, H. R., MIT Lincoln Laboratories Excess Energy Cell Final report ACC Project 174 (3), April 25, 1995.**

During the electrolysis of aqueous potassium carbonate, researchers working at MIT Lincoln Laboratories observed long duration excess power of 1-5 watts with output/input ratios over 10 in some cases with respect to the cell input power reduced by the enthalpy of the generated gas. In these cases, the output was 1.5 to 4 times the integrated volt-ampere power input. Faraday efficiency was measured volumetrically by direct water displacement.

9. **Craw-Ivanco, M. T.; Tremblay, R. P.; Boniface, H. A.; Hilborn, J. W.; "Calorimetry for a Ni/K_2CO_3 Cell", Atomic Energy Canada Limited, Chemical Engineering Branch, Chalk River Laboratories, Chalk River, Ontario, June 1994.**

Atomic Energy Canada Limited, Chalk River Laboratories, report that 128 % and 138% excess heat were observed in separate experiments by flow calorimetry during the electrolysis of aqueous potassium carbonate (K+/K+ electrocatalytic couple) in a closed cell, and that 138% was observed in an open cell.

8. **Shaubach, R. M., Gernert, N. J., "Anomalous Heat From Hydrogen in Contact with Potassium Carbonate", Thermacore Report, March 1994.**

A high temperature/high pressure/high power density industrial prototype gas cell power generator which produced 50 watts of power at 300 °C having a nickel surface area of only 300 cm^2 was successfully developed. A sample of the nickel tubing of the aqueous potassium carbonate permeation cell was analyzed by XPS at the Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA. A broad peak centered at 54.6 eV was present; whereas, the control nickel tube showed no feature. The binding energy (in vacuum) of H(n = 1/2) is 54.4 eV. Thus, the theoretical and measured binding energies for H(n = 1/2) are in excellent agreement. No excess energy or 54.6 eV feature were observed when sodium carbonate replaced potassium carbonate.

7. **Gernert, N., Shaubach, R. M., Mills, R., Good, W., "Nascent Hydrogen: An Energy Source," Final Report prepared by Thermacore, Inc., for the Aero Propulsion and Power Directorate, Wright Laboratory, Air Force Material Command (ASC), Wright-Patterson Air Force Base, Contract Number F33615-93-C-2326, May, (1994).**

In a report prepared for the Aero Propulsion and Power Directorate, Wright Laboratory, Air Force Material Command (ASC), Wright-Patterson Air Force Base, Thermacore reports, "anomalous heat was observed from a reaction of atomic hydrogen in contact with potassium carbonate on a nickel surface. The nickel surface consisted

of 500 feet of 0.0625 inch diameter tubing wrapped in a coil. The coil was inserted into a pressure vessel containing a light water solution of potassium carbonate. The tubing and solution were heated to a steady state temperature of 249 °C using an I^2R heater. Hydrogen at 1100 psig was applied to the inside of the tubing. After the application of hydrogen, a 32 °C increase in temperature of the cell was measured which corresponds to 25 watts of heat. Heat production under these conditions is predicted by the theory of Mills where a new species of hydrogen is produced that has a lower energy state than normal hydrogen. ESCA analysis, done independently by Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA, have found the predicted 55 eV signature of this new species of hydrogen."

6. **Wiesmann, H., Brookhaven National Laboratory, Department of Applied Science, Letter to Dr. Walter Polansky of the Department of Energy Regarding Excess Energy Verification at Brookhaven National Laboratory, October 16, 1991.**

Calorimetry of continuous electrolysis of aqueous potassium carbonate (K^+/K^+ electrocatalytic couple) at a nickel cathode was performed in single cell dewar calorimetry cell by Noninski at Brookhaven National Laboratory. Dr. Weismann observed the experiment and reported the results to Dr. Walter Polansky of the U. S. Department of Energy. Dr. Weismann reports, "The claim is as follows. The temperature rise in the dewar is greater in the case of electrolysis as compared to using a resistor, even though the power dissipated is equal in both cases. According to Dr. Mills' theory, this apparent "excess power" is due to the fact that the electron in a hydrogen atom can "decay" to stable subinterger quantum levels. Dr. Noninski demonstrated this thermal effect at BNL." The observed rise in temperature for a given input power was twice as high comparing electrolysis versus heater power.

5. **Nesterov, S. B., Kryukov, A. P., Moscow Power Engineering Institute Affidavit, February, 26,1993.**

The Moscow Power Engineering Institute experiments showed 0.75 watts of heat output with only 0.3 watts of total power input (power = VI) during the electrolysis of an aqueous potassium carbonate electrolyte with a nickel foil cathode and a platinized titanium anode. Excess power over the total input on the order of 0.45 watts was produced reliably and continuously over a period of three months. Evaluation of the electrolyte after three months of operation showed no significant change in its density or molar concentration. The cell was disassembled and inspected after over one month of operation at 0.1 amperes. This inspection showed no visible signs of a reaction between the electrodes and the electrolyte. The cell was re-assembled and operated as before. Excess energy was produced for the three month duration of the experiment. Scintillation counter measurements showed no signs of radiation external to the cell.

4. **Miller, A., Simmons, G., Lehigh X-Ray Photoelectron Spectroscopy Report, Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University Bethlehem, PA, November 1993.**

Samples of the nickel cathodes of aqueous potassium carbonate electrolytic cells and aqueous sodium carbonate electrolytic cells were analyzed by XPS by Miller and Simmons of the Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA. A broad peak centered at 54.6 eV was present only in the cases of the potassium carbonate cells. The binding energy (in vacuum) of $H(n = 1/2)$ is 54.4 eV. Thus, the theoretical and measured binding energies for $H(n = 1/2)$ are in excellent agreement. Lehigh University has conducted an extensive investigation of the cathodes from heat producing as well as those from control cells. Miller concludes that "I was unable to find any other elements on the surface that cause the feature. The persistent appearance of a spectral feature near the predicted binding energy for many of the electrodes used with a K electrolyte is an encouraging piece of evidence for the existence of the reduced energy state hydrogen".

3. **Jacox, M. G., Watts, K. D., "INEL XPS Report", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, November 1993.**

The Lehigh XPS results of a broad peak centered at 54.6 eV present only in the cases of the potassium carbonate cells [Miller, A., Simmons, G., Lehigh X-Ray Photoelectron Spectroscopy Report, Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA, November 1993] were confirmed at Idaho National Engineering Laboratory (INEL). Samples which demonstrated the feature as well as control electrodes were tested for the presence of trace amounts of impurities of the elements iron and lithium at a sensitivity level of greater than 1000 times that of XPS. TOF-SIMS (Time of Flight-Secondary Ion Mass Spectroscopy) and XPS analysis of the nickel surface was performed by Charles Evans & Associates, Sunnyvale, CA [Lee, Jang-Jung, Charles Evans & Associates Time-Of-Flight Secondary Ion Mass Spectroscopy (TOF-SIMS) Surface Analysis Report, CE&A Number 40150, March 18, 1994]. The 54.6 eV feature was also observed by Charles Evans & Associates in the case of cathodes of potassium carbonate electrolytic cells [Craig, A., Y., Charles Evans & Associates XPS/ESCA Results, CE&A Number 44545, November 3, 1994]. Iron and lithium were the only remaining atoms which were in question by Lehigh University and INEL as the source of the 54.6 eV XPS peak. The Charles Evans TOF-SIMS results demonstrate that iron and lithium were not the source of this peak.

2. **Lee, Jang-Jung, Charles Evans & Associates Time-Of-Flight Secondary Ion Mass Spectroscopy (TOF-SIMS) Surface Analysis Report, CE&A Number 40150, March 18, 1994.**

The Lehigh XPS results of a broad peak centered at 54.6 eV present only in the cases of the potassium carbonate cells [Miller, A., Simmons, G., Lehigh X-Ray Photoelectron Spectroscopy Report, Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA, November 1993] were confirmed at Idaho National Engineering Laboratory (INEL) [Jacox, M. G., Watts, K. D., "INEL XPS Report", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, November 1993]. Samples which demonstrated the feature as well as control electrodes were tested for the presence of trace amounts of impurities of the elements

iron and lithium at a sensitivity level of greater than 1000 times that of XPS. TOF-SIMS (Time of Flight-Secondary Ion Mass Spectroscopy) and XPS analysis of the nickel surface was performed by Charles Evans & Associates, Sunnyvale, CA. The 54.6 eV feature was also observed by Charles Evans & Associates in the case of cathodes of potassium carbonate electrolytic cells [Jacox, M. G., Watts, K. D., "INEL XPS Report", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, November 1993]. Iron and lithium were the only remaining atoms which were in question by Lehigh University and INEL as the source of the 54.6 eV XPS peak. The Charles Evans TOF-SIMS results demonstrate that iron and lithium were not the source of this peak.

1. **Craig, A., Y., Charles Evans & Associates XPS/ESCA Results, CE&A Number 44545, November 3, 1994.**

The Lehigh XPS results of a broad peak centered at 54.6 eV present only in the cases of the potassium carbonate cells [Miller, A., Simmons, G., Lehigh X-Ray Photoelectron Spectroscopy Report, Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA, November 1993] were confirmed at Idaho National Engineering Laboratory (INEL) [Jacox, M. G., Watts, K. D., "INEL XPS Report", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, November 1993]. Samples which demonstrated the feature as well as control electrodes were tested for the presence of trace amounts of impurities of the elements iron and lithium at a sensitivity level of greater than 1000 times that of XPS. TOF-SIMS (Time of Flight-Secondary Ion Mass Spectroscopy) and XPS analysis of the nickel surface was performed by Charles Evans & Associates, Sunnyvale, CA [Lee, Jang-Jung, Charles Evans & Associates Time-Of-Flight Secondary Ion Mass Spectroscopy (TOF-SIMS) Surface Analysis Report, CE&A Number 40150, March 18, 1994]. The 54.6 eV feature was also observed by Charles Evans & Associates in the case of cathodes of potassium carbonate electrolytic cells. Iron and lithium were the only remaining atoms which were in question by Lehigh University and INEL as the source of the 54.6 eV XPS peak. The Charles Evans TOF-SIMS results demonstrate that iron and lithium were not the source of this peak.

Given Applicant's full compliance with the new standards imposed by Specialist McGinty during the February 11, 2003 Interview, which required independent validation of the experimental evidence of record, Applicant is entitled to have this evidence accepted as reliable and to have this and other BlackLight applications issue as patents.

Examiner Langel's Reaffirmation of the Utility and Operability of Applicant's Novel Hydrogen Technology and His Subsequent Resignation From Examining BlackLight Cases "For Moral and Ethical Reasons"

Pursuant to the representations and agreements made during the February 11 Interview (reprinted below), Applicant followed up by submitting much of the independently generated scientific evidence cited above in two pending BlackLight applications and arranging an Interview with Examiner Langel, who was assigned to those cases and supposedly had authority to issue them. [U.S. Serial Nos. 09/110,678 ('678 application) and 09/362,693 ('693 application).] The express purpose of the Interview, held on April 14, 2003, was to review those two applications on a claim-by-claim basis to ensure that the scientific data presented adequately supported the scope of the claims. Examiner Langel expressed once again his view that the claims of the two applications were adequately supported by the data and, therefore, those claims were allowable.

A detailed account of the discussions Applicant's counsel, Jeffrey Melcher and Jeffrey Simenauer, had with Examiner Langel during the April 14, 2003 Interview, and with Examiner Langel and his supervisor, SPE Stanley Silverman, during follow-up telephone Interviews were documented in Supplemental Responses filed in the '678 and '693 applications, comments from which are reproduced below. Based on the shocking revelations divulged during these discussions, Applicant must once again protest in the strongest terms possible the manner in which an anonymous group of PTO officials (*i.e.*, the "Secret Committee") has mishandled the examination of BlackLight's patent applications relating to Applicant's novel hydrogen technology.

Counsel was particularly distressed to learn that when Examiner Langel met with Supervisor Silverman to advocate allowing the '678 and '693 applications to issue as patents, his supervisor informed him that "allowance is not an option." Despite the Examiner's

careful study of the overwhelming weight of the scientific data supporting allowance, his supervisor further instructed him to "make it appear as if you have authority [to allow the applications] and that you are in favor of full rejection."

Understandably, Examiner Langel felt uneasy having been asked to make representations on the record that were not true. He explained that, "for moral and ethical reasons," he had no choice but to allow himself to be removed from examining all assigned BlackLight applications. Although Supervisor Silverman admitted that the removal decision had been made "partially by [him] and partially by others," he would not reveal who those "others" were.

Applicant strongly objects to Examiner Langel's removal under these egregious circumstances and demands that the PTO reinstate him immediately and allow BlackLight's applications to issue. The Secret Committee is duty bound to honor the representations and agreements made by Quality Assurance Specialist Douglas McGinty during the February 11, 2003 Interview, declaring that:

(1) Examiner Langel and the other Examiners of record have "full authority" to review the scientific data supporting lower energy states of hydrogen generated and furnished by independent third parties and, based on that review, to issue patents as deemed appropriate;

(2) Applicant should confer with the Examiners, either by telephone or in person, to review each assigned application on a claim-by-claim basis to ensure that the scientific data presented adequately supports the scope of the claims; and

(3) for those claims determined to be adequately supported by the data, a patent will issue; for any claims deemed to be inadequately supported, Applicant reserves the right to continue seeking that broader claim coverage in subsequent proceedings. [See March 6, 2003 Response filed in the '678 application.]

It was precisely because of the many prior abuses that led to this short-lived "breakthrough" that U.S. Congressman David Wu sent his Senior Legislative Assistant, Ted Liu, to attend the February 11 Interview. Prior to the Interview, a senior PTO official alleged to Mr. Liu that there was no "Secret Committee." At the Interview, Mr. Liu witnessed not only Specialist McGinty's representation that Examiner Langel had the

authority to allow BlackLight's applications, but the Examiner's unequivocal statement that the applications were, in fact, allowable and that he was prepared to issue Applicant his patents right then and there. [See supra and Attachment P]

Despite those representations, an anonymous group of individuals has now declared that allowance is not even an option in BlackLight's cases. Worse yet, this Secret Committee sought to leave the false impression on the record that Examiner Langel—and perhaps other Examiners of record—had the authority to allow BlackLight's applications, and that he favored the rejection of claims over allowance.

In view of this unfortunate incident, which is described in greater detail below, Applicant is entitled to a complete accounting of events leading to Examiner Langel's removal, including identification of all persons involved in making that decision.

Detailed Account of the April 14, 2003 Interview and Subsequent Discussions

As stated above, the express purpose of the April 14, 2003 Interview was to review the scientific data generated and furnished by independent third parties identified in the March 6, 2003 Response that was filed in the '678 and '693 applications in support of the lower energy states of hydrogen and to ensure that the data adequately supported the scope of the claims to secure their allowance.

Applicant had no reason to suspect that this new approach, as agreed to during the prior February 11, 2003 Interview, was about to be completely scrapped. During the subsequent April 14, 2003 Interview, Examiner Langel once again reaffirmed his long-held opinion that the scientific data submitted by Applicant confirmed the operability of his novel hydrogen technology, thus warranting patent protection. The Examiner's comments made clear that, prior to the interview, he had extensively reviewed Applicant's data, as well as the summary statements characterizing that data, appearing in the prior Responses filed in the '678 and '693 applications. Based on that review, Examiner Langel expressed several times during the Interview his willingness to allow those cases. Those views were confirmed by the Examiner in his interview summary, which stated that "[t]he participants presented data establishing the existence of lower-energy hydrogen." [See April 14, 2003 Interview Summary Form filed in the '678 and '693 applications (Attachment F).]

Examiner Langel, however, refrained from indicating allowance of any specific claims for two stated reasons. First, a few items of submitted data summarized in the March 6 Response inexplicably could not be located in the PTO files. The Examiner wanted time to confirm the data had been made of record, as well as Applicant's description of its relevance. Second, despite Specialist McGinty's representation at the February 11 Interview that Examiner Langel had full authority to review the data and to issue claims in the two interviewed cases, the Examiner explained that he needed to advise him and Supervisor Silverman of his intention to do so.

Examiner Langel then recalled a recent visit to his office by Group Director Jacqueline Stone informing him—again, contrary to what Applicant was told at the February 11, 2003 Interview—that he did not have authority to issue Notices of Allowance, or to otherwise give indications of allowance, in any BlackLight applications. Director Stone instructed Examiner Langel that he would need Specialist McGinty's permission before doing so.

Examiner Langel did, however, note that Supervisor Silverman and Specialist McGinty had agreed before the February 11 Interview to allow claims if Applicant could show that his submitted scientific data was generated by independent third parties. The Examiner reassured counsel that he would present to his superiors the scientific data discussed at the April 14 Interview with a recommendation of allowance consistent with his past views.

Applicant's counsel agreed that it made sense to allow time for Examiner Langel to discuss the case with his superiors and for counsel to resubmit the few missing items of scientific data, whereupon arrangement was made to continue with the personal Interview on the following day, April 15th. That morning, however, counsel received a distressing telephone message from Examiner Langel informing him that the Interview had been canceled. The Examiner stated that Supervisor Silverman had removed him from the subject cases and that he was no longer assigned to any BlackLight applications.

Applicant's counsel immediately telephoned Examiner Langel for a further explanation of what had happened. The Examiner confirmed his removal following the meeting he had arranged with Supervisor Silverman to discuss the scientific data that

had been the subject of the previous day's Interview and to advocate allowance of the claims in the two subject applications. Examiner Langel informed counsel that his supervisor refused to even look at the data and, in response to his recommendation of allowance, Supervisor Silverman told him "allowance is not an option." According to Examiner Langel he was then told: "Make it appear as if you have authority [to allow the applications] and that you are in favor of full rejection."

Examiner Langel explained that, regrettably, he had no choice but to resign from further examination of BlackLight's applications. According to the Examiner, Supervisor Silverman gave him the option of staying on, "but not really—I could not go on like this." He explained that "for moral and ethical reasons," he could no longer continue to examine his assigned cases.

Alarmed by this sudden turn of events, counsel called Supervisor Silverman the following day, April 16th, to object to Examiner Langel's removal and to seek his reinstatement. Supervisor Silverman confirmed that Examiner Langel would no longer be examining Blacklight's patent applications and that all of its cases were in the process of being consolidated and transferred to a new Examiner.

Counsel kindly requested that Supervisor Silverman explain why those cases were being transferred and who made that decision. He initially refused to discuss the matter, saying only that, "I am not going to be put on the stand and cross examined on this." Upon further prodding, Supervisor Silverman volunteered that "the decision was made partially by me and partially by others." He refused, however, to be more specific when asked to identify the "others" involved in the decision, stating "I am not going to discuss that. You can say that it was *my* decision."

Counsel then informed Supervisor Silverman of Applicant's intention to file an objection to Examiner Langel's removal and to the consolidation and transfer of BlackLight's applications to a new Examiner. Counsel explained that Applicant had expended enormous amounts of time and money over a period of many years prosecuting BlackLight's patent applications before Examiner Langel and getting him up to speed on the claimed technology and the extensive scientific data confirming its operation. Counsel argued that it was unfair now to remove Examiner Langel and transfer all of BlackLight's cases to a new Examiner just to begin the process all over

again. Supervisor Silverman would hear none of it, again stating, "I'm not going to discuss it."

Applicant's counsel made one last attempt to learn the identity of the other PTO officials responsible for taking that drastic action and their reasons for doing so. Supervisor Silverman again refused this request for information, snapping at counsel, "You figure it out!" Counsel then asked the Supervisor whom they might talk to so they could "figure it out" as he put it. Supervisor Silverman advised counsel, "Talk to whomever you want," but when asked whom specifically he had in mind, he again retorted, "I don't like to be cross-examined."[110]

At the end of the conversation, Supervisor Silverman attempted to justify the PTO's extreme actions by claiming that it was in the "best interest" to transfer the applications. But, when asked by counsel whose best interest was being served by the transfer, he refused to answer. Instead, Supervisor Silverman offered a stunning revelation that Applicant's novel hydrogen technology was "beyond Examiner Langel's technical expertise" and that all of the BlackLight cases would be consolidated and transferred to another examiner with "more technical expertise." He would not elaborate on who this new, more highly qualified Examiner might be.[111]

Needless to say, at no time during the five years Applicant had been prosecuting his patent applications before Examiner Langel—who has over thirty years of Patent Office experience—did his technical expertise ever come into question. Indeed, throughout the lengthy prosecution of these cases, counsel has been impressed with the Examiner's in-depth knowledge of chemistry and physics, as well as other scientific principles, underlying Applicant's novel hydrogen technology. That Supervisor

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[110] Counsel has taken steps "to figure it out" and expressly reserves the right to further supplement the objections raised herein as additional facts come to light. (Attachment R)

[111] Supervisor Silverman's statement that all of BlackLight's applications were being consolidated and transferred to a single, more qualified Examiner turned out to be untrue. In fact, Applicant's cases remained spread between four named Examiners, not one: Examiners Kalafut, Tsang-Foster, Wells, and Wayner (since retired). While it may be true that management of all of these cases were taken over by a newly identified Examiner, Dr. Bernard Eng-Kie Souw, whose views now form the primary basis for the Committee's rejections issued in the name of those other Examiners, is far less experienced in patent matters than his predecessors. Furthermore, as discussed in detail below, Dr. Souw's views are not only technically inaccurate, but are also fatally tainted due to a genuine conflict of interest based on his involvement in questionable outside business activities while examining Applicant's cases.

Silverman would raise Examiner Langel's technical competence as an issue at such a late stage of that prosecution only heightens Applicant's suspicions as to the real motivation for removing Examiner Langel.

Immediately following the conversation with Supervisor Silverman, counsel telephoned Examiner Langel one last time to apprise him of the situation and to thank him for his many years of service in examining BlackLight's applications. Examiner Langel expressed regret over his removal from those cases and confirmed that he had "learned a lot about [BlackLight's] technology." The Examiner also expressed surprise that his expertise was now being called into question.

Examiner Langel shared counsel's exasperation over the situation. Counsel asked him if he knew of any other instances in which a PTO Examiner had been instructed to represent that he had authority to allow an application when, in fact, he had no such authority, and that he favored rejecting claims when he actually wanted to allow them. The Examiner's exact words were: "I've never seen anything like it."

Frankly, neither has Applicant's counsel and, in view of these unique circumstances, Applicant must once again strenuously object to the abusive treatment to which his applications have been subjected.

**Other Questionable Actions by the Secret Committee Further
Demonstrate Its Unwillingness to Grant Applicant a Fair Hearing**

As discussed above, Examiner Langel initially advised Applicant that a Committee of PTO officials he could not identify was responsible for authoring the Office Actions he was instructed to sign as the named Examiner of record in the cases assigned to him. Examiner Kalafut later confirmed that he was also merely the named Examiner of record and that he too did not author the Office Actions issued by the Committee in his cases. Given that these two senior PTO employees, having over 50 years of experience between them, were being used as Examiners-in-name-only by this "Secret Committee," Applicant found it odd that another Examiner, William Wayner, would make the following statement in another BlackLight application to which he was assigned:

For the record this Examiner makes it clear that there is no committee in charge of this application, that all of the office actions in this case have been done by me alone an[d] that I have never been told that I could not allow this application. [See April 26, 2004 Office Action issued in U.S. App'n Ser. No. 09/181,180 ('180 application).]

Applicant's initial doubt regarding the veracity of that statement was confirmed in an initial telephone conversation held on October 5, 2004, between Applicant's counsel, Jeffrey A. Simenauer, and Mr. Wayner, following his retirement from the PTO as an Examiner, and in a follow-up telephone conversation held on October 25, 2004.

Sometime in mid-September, Mr. Wayner had called and left Mr. Simenauer, a former PTO colleague, a telephone message informing him of his retirement and his desire to secure patent search work to do in his spare time. Mr. Simenauer returned Mr. Wayner's call and spoke to him on October 5th about doing some possible work, after which the conversation turned to Mr. Wayner's involvement in the examination of the '180 application. The substance of that conversation was confirmed in an e-mail Mr. Simenauer sent to Mr. Wayner on October 15, 2004. [See Tab S]

During the October 5 phone conversation, Mr. Wayner was very candid in complimenting Dr. Mills for the way he had handled himself during the February 11, 2003 Interview, commenting that "Mills is one hell of a persuasive man" and that "he came across as very convincing" at the Interview. In his October 15 e-mail, Mr. Simenauer thanked Mr. Wayner for those comments, which he indicated had been forwarded to Dr. Mills.

Mr. Simenauer then told Mr. Wayner that, while he disagreed with the positions Mr. Wayner had expressed during the Interview, including his skepticism regarding the operability of Mills' invention, he still respected those views. Mr. Simenauer, however, made clear to Mr. Wayner that what really upset him were the questionable actions that the PTO has taken against BlackLight prejudicing its patent rights. In that regard, Mr. Simenauer recalled Examiner Langel's resignation from examining Applicant's cases "for moral and ethical reasons" due to instructions he had been given to misrepresent the record to promote the PTO's "allowance is not an option" policy. Specifically, Mr. Simenauer reminded Mr. Wayner of how Examiner Langel was told to say that he was

against allowing Dr. Mills' applications, when in fact he favored doing so, and that he had authority to issue Dr. Mills his patents, when he clearly had no such authority.

Mr. Wayner confirmed this official position of the Patent Office "not to allow [Dr. Mills'] cases" and admitted that he could not tell Mr. Simenauer this while he was still working at the PTO. As stated in his October 15 e-mail, Mr. Simenauer appreciated Mr. Wayner's honesty and understood why he had previously remained silent.

As further stated in his e-mail, Mr. Simenauer had first decided not to ask Mr. Wayner to go "on the record" with this information, given that Applicant already had a record of Examiner Langel's statements that the PTO had in place an "allowance is not an option" policy and that he was asked to misrepresent his authority to issue patents in BlackLight's cases. Mr. Simenauer mentioned, however, that a problem had arisen that had caused him to reconsider that decision. Mr. Simenauer explained that his review of Mr. Wayner's last Office Action in the '180 application had turned up the above-quoted statement that "I [Wayner] have never been told that I could not allow this application," which contradicted what Mr. Wayner had told Mr. Simenauer previously on the phone regarding his lack of authority to allow it.

In view of Examiner Langel's admission that he was told by senior PTO officials that he did not have authority to allow BlackLight's applications under any circumstances, but that he should give the false impression that he did have such authority, Mr. Simenauer expressed concern in his October 15 e-mail that the PTO might have put Mr. Wayner in a similar uncomfortable position when he stated that he had authority to allow the '180 application. Mr. Simenauer then informed Mr. Wayner that, as BlackLight's patent counsel, he was obligated to press the matter. Knowing Mr. Wayner to be "a man of utmost integrity," Mr. Simenauer further stated that he felt comfortable requesting "[his] assistance in simply uncovering the true facts regarding the PTO's policy decisions that have been made against BlackLight."

In response to Mr. Simenauer's e-mail, Mr. Wayner called him on October 25, 2004 and left a message, which call was then returned the same day by Mr. Simenauer and the undersigned co-counsel, Jeffrey S. Melcher. At no time during this subsequent telephone conversation did Mr. Wayner deny the substance of his earlier October 5th conversation with Mr. Simenauer as reflected in the October 15th e-mail. Rather, Mr.

Wayner started the conversation by saying, "You should know better. I don't want to get involved in this anymore." Mr. Wayner further stated that he did not want to talk any further about the subjects discussed in Mr. Simenauer's confirmation e-mail and that, in his words, "you will have to go by what's on the record," making clear to Applicant's counsel that he would not accept their request for assistance regarding the truth of his statements in the present Office Action.

Mr. Wayner also stated that while he wanted to continue his personal friendship with Mr. Simenauer, he also wanted "to stay out of the [BlackLight] case." Mr. Simenauer apologized for troubling him with this matter and informed Mr. Wayner that he may not be able to remain out of the BlackLight case against the PTO if it were to go to trial following an appeal to the PTO Board. Somewhat nervously, Wayner responded by stating that "it is a very dangerous situation" for him, and again made clear that he did not want to talk about it any further. Mr. Simenauer told Mr. Wayner that he understood and sympathized with his situation and that he did not want to put him in the uncomfortable position of having to say anything more on the subject.

Mr. Wayner then stated that he had changed his mind about seeking search work from Mr. Simenauer as he had initially requested since, in his words, "I don't want it to look like a *quid pro quo*." Again, Mr. Simenauer expressed his understanding of the situation Mr. Wayner found himself in and that ended the conversation.

In light of these unfortunate developments, Applicant must demand that the PTO Committee cease and desist from any further attempts to cloud the administrative record in his cases so as to make it appear that the "Examiners-in-name-only" are solely responsible for its actions. As with the situation involving instructions that led to Examiner Langel's resignation "for moral and ethical reasons," Applicant further demands that the Committee provide a complete account of the facts and circumstances that led to the questionable statements appearing in the Office Action signed by Examiner Wayner in the '180 application prior to his retirement.

The Secret Committee Has Demonstrated Extreme Bias In Its Handling of BlackLight's Patent Applications Due to Genuine Conflicts of Interest

Following Examiner Langel's unfortunate resignation from examining BlackLight's applications, the Committee consolidated those cases under a new, supposedly more experienced Examiner. Consequently, the Committee's rejections of Applicant's claims in this and other pending BlackLight applications based on inoperability due to the alleged non-existence of lower-energy hydrogen now rely heavily, if not almost exclusively, on the views expressed by that new Examiner, Dr. Bernard Eng-Kie Souw. Indeed, Dr. Souw is known to have prepared on behalf of the Committee over one hundred pages of arguments, which in one form or another, have now found their way into all of BlackLight's cases in support of the Committee's rejections.

As explained in more detail below, Dr. Souw's involvement in shaping the Committee's views in this case raises serious questions regarding the biased nature of those views due to his genuine conflicts of interest. In fact, Dr. Souw's biased views have so tainted the present rejections that the Committee must withdraw those rejections and allow the pending claims to issue.

The Committee's Refusal To Disclose the Details of Dr. Souw's Employment History Raises Serious Questions Of Whether It Is Capable Of Fairly Examining Applicant's Cases

The Committee's appointment of Dr. Souw came at a critical juncture in the examination of Applicant's pending cases. As explained above, in April 2003, Examiner Langel, one of the two original examiners assigned to these cases, had resigned from his examining duties "for moral and ethical reasons." Examiner Langel's abrupt resignation came after being instructed to misrepresent that he favored denying Applicant his patents when the record showed he wanted to allow those patents to issue, and that he had authority to grant such allowance when, in fact, he was told that "allowance is not an option."

To justify Examiner Langel's resignation after the fact, the PTO informed Applicant that his cases were being transferred and consolidated under the direction of an Examiner with "more technical experience." A few short weeks later, Dr. Souw

began making appearances in Applicant's cases even though he had only a few years of experience as an Associate Examiner, as compared to Primary Examiner Langel, who had over thirty years of PTO examining experience. [See Appendix attached to the Committee's May 7, 2003 Office Action issued in U.S. App'n Ser. No. 09/513,768 ('768 application).] Examiner Langel also demonstrated a much better technical understanding of Applicant's technology judging by the error-riddled arguments found throughout Dr. Souw's Appendices.

Applicant was naturally suspicious of Dr. Souw's prominent membership on the Committee given the prosecution history of BlackLight's pending applications already discussed. As further detailed below, this new appointment prompted Applicant to raise initial questions regarding Dr. Souw's employment history after he first showed bias in examining these cases by citing his own technical papers against Applicant. Rather than answer those questions, the Committee stonewalled once again, defensively arguing that:

> [T]he employment history of examiners, including those acting in a consulting role, is irrelevant to the examination thereof, except where there is a genuine conflict of interest. [See 4/14/04 Office Action in U.S. App'n Ser. No. 09/008,947 at p. 5.]

Dr. Souw has been similarly uncooperative, although he did provide some limited information regarding his employment history by citing to his background in microwave plasmas:

> Since the cited Examiner's papers cannot possibly have been criticized by Applicant, citing his own publication(s) does not make the Examiner's view "biased", as alleged by Applicant. In the contrary, such technical papers provide a solid evidence that the Examiner is in possession of sufficient background for evaluating Applicant's claimed invention. In this regard, the Examiner can add a further evidence of strong background in microwave plasmas generated in a resonance cavity similar to those use by Applicant, not only in theory, but also hands-on in its design, construction and routine operation, as well as in its spectroscopy, both low and high resolutions [1]. [Souw Appendix at p. 4 attached to the March 29, 2004 Office Action filed in the '768 application.]

The reference [1] cited by the Examiner as evidence of his supposed "strong background in microwave plasmas" is an article published in March 1987: Souw, Eng-

Kie, Plasma density measurement in an imperfect microwave cavity, J. Appl. Phys. 61 (5), 1 March 1987.[112]

The Committee's defensive remarks regarding the irrelevancy of Dr. Souw's employment history, when contrasted with the Examiner's own remarks extolling the relevancy of that history, are truly astounding. The Committee's statements are even more remarkable, however, when considered in the context of additional information that has come to Applicant's attention concerning Dr. Souw's engagement in questionable business activities that began before, and continued after, all of BlackLight's pending applications were consolidated and assigned to Dr. Souw.

This information came to light only after Applicant, unable to get straight answers from the Committee regarding Dr. Souw's background, undertook his own investigation into the Examiner's employment history. That investigation uncovered a much more recent 2003 article authored by Dr. Souw, in which he admits that he worked as the lead scientist for a consulting company that he co-founded, BMS Enterprise (BMS) in Herndon, Virginia, at the same time he worked for the PTO examining BlackLight's applications. Dr. Souw also admits in the article that his business activities for BMS includes work in at least two technical areas, which are identical to, and therefore compete with, those practiced by BlackLight.[113] Given that one of those technical areas is microwave plasmas, it is highly suspicious that the Committee and Dr. Souw withheld this highly relevant, up-to-date work experience in support of his supposedly "strong background in microwave plasmas," citing instead an outdated, 17-year-old article in support. The reason the Committee and Dr. Souw withheld this important information is obvious: if correct—and Applicant has no reason to doubt this given that the source is Dr. Souw himself—there would appear to be multiple violations of the PTO's own ethics

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[112] Ironically, Dr. Souw attempts to establish his credibility in evaluating Applicant's novel hydrogen technology by citing his peer-reviewed article published in the *Journal of Applied Physics*, yet argues that Applicant's article published in that very same journal does not establish similar credibility. In taking those contradictory positions, the Committee reveals yet another double standard that only reinforces its bias against Applicant.

[113] Incredibly, since the time Applicant first brought this information to the PTO's attention in his October 14, 2004 Response filed in U.S. Patent App'n Ser. No. 09/008,947, and subsequently in other pending cases, not only has the PTO failed to seriously address the issues raised, but it continues to cite and rely on Dr. Souw's biased arguments. These actions leave Applicant no choice but to seek other avenues for relief from this unfair treatment.

rules. At the very least, the ability of the Committee under the direction of Dr. Souw to fairly evaluate the merits of Applicant's novel hydrogen technology has once again been called into serious question.

The above-mentioned article was published in *Optical Engineering* on November 2, 2003. [Souw, Bernard Eng-Kie, Coherent telescope array with self-homodyne interferometric detection for optical communications, Opt. Eng. 42(1) 3139-3157 (November 2003) (Tab S).] As the author of that article, Dr. Souw's name prominently appears on first page (p. 3139), identifying his association with BMS as follows:

> Bernard Eng-Kie Souw
> BMS Enterprise
> P.O. Box 5524
> Herndon, Virginia 20172-5524
> E-mail: souw1@juno.com

The last page of the article (p. 3157) is particularly informative as it summarizes Dr. Souw's technical background and work experience establishing his connection to BMS as its co-founder and lead scientist. Applicant reproduces the following relevant portions of that background summary, which notably describes BMS as providing consulting services in two main technical areas, microwave plasma devices and CVD diamond synthesis and applications, that are identical with those practiced by BlackLight:

> In 1985, [Bernard Eng-Kie Souw] joined Brookhaven National Laboratory (BNL) in Long Island, New York as staff member in a Star Wars project. He was awarded a Department of Energy research grant in 1993 and became Principal Investigator in a research and development project on a novel, solar blind and fieldable alpha-beta-gamma radiation detector in collaboration with Northrop-Grumman and New Jersey Institute of Technology. **About the same time he cofounded BMS Enterprise, a multi-interdisciplinary consulting company providing services mainly in microwave plasma devices and CVD diamond synthesis and applications. He left BNL in 1997 and became a patent examiner with the US Patent and Trademark Office in Arlington, Virginia until 2000, when he joined ITT Industries in Reston, Virginia as a scientist and engineering specialist in optical communications. He left ITT in 2002 to dedicate more time as lead scientist with BMS Enterprise.** [Emphasis added.]

As the Committee is no doubt aware, Applicant's novel hydrogen technology has many potential commercial applications, including the aforementioned microwave plasma devices and CVD diamond synthesis. Indeed, Applicant presently has on file two copending applications directed to these specific art areas. [See U.S. App'n Ser. No. 10/469,913, filed March 7, 2002; and PCT/US/13412, filed May 1, 2002.] Applicant has serious concerns that these and other competitive technologies that BMS and BlackLight engage in may have affected, and will continue to affect, the manner in which the Committee has examined and rejected his applications.

This situation is particularly disturbing in light of PTO ethics rules that prohibit patent examiners from engaging in outside business activities that conflict with their assigned administrative duties. [See *Summary of Ethics Rules* for the U.S. Patent and Trademark Office published by the U.S. Department of Commerce, Office of the General Counsel, Ethics Division (2000) (Tab S)] As the introductory paragraph to these ethical rules makes clear, the issue involved here is one of public trust:

PUBLIC SERVICE IS A PUBLIC TRUST

As an employee of the U.S. Patent and Trademark Office you have been placed in a position of trust and are held to a high standard of ethical conduct. This handout contains a summary of the rules set forth in conflict of interest statutes and the *Standards of Ethical Conduct for Employees of the Executive Branch.* [Ethics Rules at p. 1 (Tab S)]

To hold examiners to this high standard of ethical conduct, the rules prohibit activities that would create a financial conflict of interest:

Financial Conflicts of Interest. You may not, as part of your official Government duties, participate in any matter that will have a direct and predictable effect on your personal financial interest, unless an exemption applies. This rule applies to matters involving specific parties in which you have a financial interest and to broad policy matters that affect many entities, including ones in which you have an interest (such as a policy affecting an entire industry sector if you have stock holdings in one of the companies in the industry sector). [Ethics Rules at p. 2 (Tab S) (emphasis in original).]

Other PTO ethic rules govern outside employment activities:

General Rule on Outside Activities. You <u>may not</u> engage in outside employment or any other personal activity that conflicts with your Department position, including employment that requires disqualification from a significant part of your Government duties or an activity that creates an appearance of using your public office for private gain. You must disqualify yourself from participating in a matter as a Department employee which may affect the financial interests of an outside employer or in which an outside employer, or an organization in which you are an active participant, is a party or is representing a party. . . . [Ethics Rules at p. 5 (Tab S) (emphasis in original).]

These restrictions against financial conflicts of interest and outside employment activities are further amplified with specific reference to patent examiners in the following rules:

Financial conflicts of Interest

<u>Conflicts of Interests regarding Patent Examiners</u> If you are a patent examiner, you may not participate in the review of any patent if you have a financial interest in a company that may be affected by the issuance or denial of the patent (unless your interest is in publicly-traded stock valued at $5,000 or less in all affected companies). . . . [Ethics Rules at p. 10 (Tab S)]

Outside Employment and Activities

<u>Service with Non-Federal organizations</u> If you serve as an officer or director of an outside organization, such as a professional association, you <u>may not</u> participate as a USPTO employee on any matter that is likely to affect the financial interests of the organization. This may preclude you from serving with organizations that are active in matters before your office. If it would benefit USPTO to have an official relationship with a private organization, you may be assigned as a liaison to the organization, in which case your service with the organization would be in an official capacity, rather than as an outside activity. However, you may not be assigned to service in an official capacity as an officer or director of a non-Federal organization (other than a standards-setting body). [Ethics Rules at p. 11-12 (Tab S) (emphasis in original).]

The applicability of these ethics rules to the present situation cannot be seriously disputed. Dr. Souw was employed as a PTO Examiner at the same time he admits to being the lead scientist for BMS with an apparent ownership stake in the company, which has a competing interest with BlackLight. Indeed, records indicate that Dr. Souw

was a PTO employee prior to the date *Optical Engineering* first received his BMS article on February 6, 2003, and throughout the time that paper was being revised and received on May 6, 2003, and ultimately published on November 2, 2003.[114]

The article's May 6, 2003 revision date is particularly significant. It was only <u>one</u> day later, on May 7, 2003, that the Committee began issuing rejections in BlackLight's pending cases based on Appendices authored by Dr. Souw, starting with the '768 application. Dr. Souw's genuine conflict of interest in working for BMS during his employ as a PTO examiner—and while rejecting a competitor's patent applications no less—should be obvious to any fair-minded person and, thus, requires no further discussion.[115]

This clear conflict of interest is especially troubling given the many other questionable activities that have occurred in the prosecution of BlackLight's applications as documented and described above, including:

(1) the withdrawal from issue of five allowed BlackLight applications under highly suspicious circumstances involving interference by Dr. Robert Park, spokesman for the American Physical Society (APS), a BlackLight competitor;

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[114] See, for example, U.S. Patent No. 6,506,648, issued January 14, 2003, which identifies Bernard Souw as the Assistant Examiner. Based on established PTO procedures, Examiner Souw is believed to have been a PTO employee when the Notice of Allowance was issued in that case, well before January 2003.

[115] Interestingly, Dr. Souw mentions in his article that he co-founded BMS in 1993 while working for BNL and that he left BNL in 1997 to join the PTO, apparently while still operating BMS. According to the article, Dr. Souw then left the PTO in 2000 to join ITT Industries as a scientist/engineer in the optical communications field until 2002, when he left "to dedicate <u>more</u> time as lead scientist with BMS Enterprise." [Emphasis added.] Dr. Souw, however, notably fails to mention in the BMS article his apparent re-employment by the PTO, which failure, incidentally, <u>does</u> comply with at least one PTO ethics rule: "you <u>may not</u> use your Government title in connection with a non-Government activity." [[Ethics Rules at p. 7 (Tab S) (emphasis in original)]

Also somewhat troubling is that Dr. Souw apparently continues to examine and issue applications in other art areas that overlap with his scientific work for BMS, including optical communications, which is the subject matter of his published article. [See, e.g., U.S. Patent No. 6,801,676, filed June 24, 2003 and issued October 5, 2004, on a "Method and apparatus for phase shifting an optical beam in an optical device with a buffer plug" (recognizing in the "Background of the Invention" section that "the need for fast and efficient optical-based technologies is increasing as Internet data traffic growth rate is overtaking voice traffic pushing the need for optical communications.")]

(2) the admission by Dr. Park's APS colleague, Dr. Peter Zimmerman, that Dr. Park has a "Deep Throat" contact at the Patent Office who has provided him with information concerning BlackLight applications;

(3) the rejection of Applicant's claims based on a non-peer reviewed article posted on an Internet bulletin board authored by Dr. Zimmerman, who has bragged that while working at the State Department his agency and the Patent Office "have fought back with success" against BlackLight;

(4) Dr. Zimmerman's improper contact of scientific journals in an attempt to prevent Applicant from meeting the publication requirement imposed by the Committee before his experimental evidence would even be considered; and

(5) Examiner Wayne Langel's untimely resignation from the examination of BlackLight's applications for "moral and ethical reasons" after being told to materially misrepresent the record and that "allowance is not an option" in these cases.

In view of this sordid prosecution history, Applicant is understandably outraged by the discovery that following Examiner Langel's unfortunate resignation, the Committee appointed Dr. Souw to continue carrying out its "allowance is not an option" policy while he represented a competing interest. Applicant has demanded several times that the PTO provide a complete accounting of the facts and circumstances surrounding prior questionable activities, including those summarized above. Applicant has made a similar demand for information in connection with this latest episode involving Dr. Souw's conflicted association with BMS Enterprise while assigned to examine and reject BlackLight's pending patent applications. Applicant now repeats that demand for information here, including but not limited to a full disclosure of the facts and circumstances surrounding Dr. Souw's:

(1) appointment as an examiner assigned to review BlackLight's pending patent applications;

(2) outside business activities with BMS Enterprise, and with any other business ventures in which he has a financial interest;

(3) contact with any sources outside the PTO with regard to the subject matter disclosed in any of BlackLight's applications; and

(4) membership activities or any other participation in any professional organizations, including the APS.[116]

Unfortunately, like Applicant's many other information requests, this one too has been ignored by the Committee despite the serious implications of Dr. Souw's genuine conflict involving his outside business activities. The Committee's refusal to honor these requests, however, only raise further suspicions that there is more information that would only strengthen Applicant's case for a genuine conflict of interest.

Instead of being forthcoming with the true facts and circumstances surrounding that conflict, the Committee initially tried to obscure it by advancing irrelevant and factually inaccurate arguments that contradicted Dr. Souw's own admissions:

> Applicant's remarks concerning examiner Souw, and the article (Attachment S) are noted. This article deals with a telescope array, and does not appear to show any conflict of interest between Dr. Souw's former employer, BMS Enterprise, and his consulting involvement with the present application. [See 12/21/04 Advisory Action filed in U.S. App'n Ser. No. 09/362,693 at p. 2 (emphasis added.)]

The Committee's carefully crafted denial of Dr. Souw's obvious genuine conflict of interest only raised further suspicions by its failure to even address Applicant's basis

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[116] This information is deemed relevant to the following additional PTO ethics rule:

Appearances of Bias (non-Financial Conflicts of Interest)

Participation in Professional Organizations If you are an active member of a professional organization, such as a member of a[n] association of attorneys or patent professionals, you will be barred from participating in USPTO on matters in which that organization is a party or is representing a party. If this will interfere with your USPTO duties, you should refrain from such activities or should seek advice from the Ethics Division. . . . [PTO Ethics Rules at p. 10 (Tab S)]

As explained in detail above, and in previous Responses, Applicant has good reason to believe that the APS, and perhaps other professional organizations, have become involved as parties in these proceedings.

for asserting the conflict. While the Committee claims to have noted Applicant's remarks regarding this issue, it is apparent from its initial brief response that, true to form, those remarks were wholly ignored.

The Committee's refusal to seriously address the conflict in this case is clear from its narrow focus on the subject matter of the Souw article. Although the Committee correctly notes that the article "deals with a telescope array," that fact is totally irrelevant and, thus, cannot possibly support the Committee's conclusion that the article "does not appear to show any conflict of interest." [Emphasis added.]

Applicant has never relied on the subject matter of Dr. Souw's article as a basis for establishing a conflict in the present application. Rather, as previously discussed, that showing is based upon Dr. Souw's admission in the background summary of the article that he co-founded BMS Enterprise and has continued to operate the company as its lead scientist. In that capacity, he works in two main technical areas—microwave plasma devices and CVD diamond synthesis and applications—identical to those practiced by Applicant while also employed by the PTO to examine and reject Applicant's cases. The Committee's initial refusal to even acknowledge that aspect of Applicant's showing of a genuine conflict of interest in this case, much less discuss it, is telling and only confirms Applicant's showing that a conflict does indeed exist.

The Committee further attempted to gloss over Dr. Souw's startling admission that he operates a business enterprise that competes with Applicant's business interests while examining his cases by claiming that the subject matter of the article, i.e., a telescope array, does not establish a conflict of interest "between Dr. Souw's former employer, BMS Enterprise, and his consulting involvement with the present application." [Emphasis added.] Aside from being non-responsive, this argument is also factually inaccurate.

The Committee incorrectly refers to BMS as a "former employer," in contradiction to Dr. Souw's admissions that he co-founded BMS and, therefore, is presumably a principal owner of the company, and that he continued to operate the company after he was employed by the PTO as an Examiner. The Committee merely compounded its error based on the alleged "former employer" status of BMS with the unfounded conclusion that no conflict of interest exists between Dr. Souw's work for BMS as its

lead scientist and his work for the PTO as the Examiner primarily responsible for examining and rejecting Applicant's cases. In drawing this erroneous conclusion, the Committee all but admits the obvious—that Dr. Souw's <u>current</u> employment with BMS does in fact create a genuine conflict of interest, which then taints the Committee's rejections in all of Applicant's cases.

Perhaps realizing the incoherence of its initial response regarding the issue of Dr. Souw's apparent conflict of interest, the Committee, in a subsequent response, drastically changed its position. Although the Committee no longer tries to mischaracterize BMS as a "former employer," astonishingly, it now argues that Dr. Souw's continued operation of that company while he examined and rejected Applicant's patent applications does not create a conflict:

> Applicant also implies (page 108) that Dr. Bernard Souw, who has been consulted during the examination of his applications, is also involved in work "competitive" to this [sic] own, which would produce a conflict of interest. The evidence offered by applicant, an article written by Dr. Souw, deals with a telescope array, which is neither an alternative form of hydrogen nor a new previously unappreciated source of energy, and thus does not appear to be competitive with the present "hydrino" or any battery based thereon. While the biographical sketch at the end of the article mentions his involvement in consulting work having to do with microwave plasma devices and CVD diamond synthesis, this would not amount to competition with the present invention or the underlying hydrinos. Diamonds are a form of carbon, and thus are not in competition with hydrogen. Microwave plasma devices are not necessarily related to hydrogen, since they are a type of device or machine. [2/11/05 Office Action at page 4 filed in U.S. App'n Ser. No. 09/110,717.]

The Committee's latest arguments regarding Dr. Souw's conflicting business activities are no more convincing than those previously posited and, in fact, raise so many new issues, Applicant hardly knows where to begin. First, Applicant did not "imply" anything; rather, he simply quoted relevant portions of Dr. Souw's own article admitting to outside business activities that clearly conflict with technologies practiced by Applicant whose pending patent applications has examined and rejected. That alone is sufficient to establish a genuine conflict of interest that fatally taints the biased views of Dr. Souw, which have been universally adopted by the Committee.

Second, the Committee's comment regarding "the evidence offered by Applicant" is disturbing. It is not Applicant's responsibility to "offer" evidence that the Committee itself should have produced in the first place. Worse yet, the Committee continues to withhold additional evidence responsive to Applicant's reasonable request for background information relevant to Dr. Souw's employment history and any conflicts and biases he may have. If and when the Committee decides to cooperate in supplying the requested information, there no telling what additional genuine conflicts of interest will arise in this case based on that "the evidence offered by Applicant."

Third, as previously discussed, the Committee's reliance on the subject matter of the article, i.e., a telescope array, is a "red herring" that has absolutely nothing to do with the conflict issues surrounding Dr. Souw's questionable business activities. Applicant has never once asserted that Dr. Souw's work in the area of telescope arrays creates a genuine conflict of interest in this case. For the Committee to raise this as an issue merely highlights the desperation of its latest arguments, further exposing the weakness of its position.

Fourth, the Committee uses strained reasoning in asserting that Dr. Souw's admission to his involvement in consulting work relating to microwave plasma devices and CVD diamond synthesis "would not amount to competition with the present invention or the underlying hydrinos." As explained above, and in other numerous responses, one direct application of the BlackLight's lower-energy hydrogen technology is CVD diamond synthesis, which subject is covered by claims in one of its pending patent applications. For the Committee to ignore this plain, simple fact and weakly argue instead that "[d]iamonds are a form of carbon, and thus are not in competition with hydrogen" merely demonstrates its refusal to take the conflict issue seriously. Similarly, the Committee's excuse that "microwave plasma devices are not necessarily related to hydrogen, since they are a type of device or machine" hardly merits a response. The formation of microwave plasmas is again a direct application of BlackLight's lower-energy hydrogen technology covered by claims in one of its pending patent applications.

Fifth and finally, the PTO members of the Committee know better than anyone that "competition" between the Examiner and the Applicant whose case he is examining

is not the proper standard used in determining the presence of a conflict of interest.

Indeed, PTO's own Ethics Rules, as discussed above, forbid an Examiner from

engaging in outside employment activities that create even the appearance of

impropriety:

> **General Rule on Outside Activities.** You may not engage in outside
> employment or any other personal activity that conflicts with your
> Department position, including employment that requires disqualification
> from a significant part of your Government duties or an activity that
> creates an appearance of using your public office for private gain. . . .
> [Ethics Rules at p. 5 (Tab S) (emphasis in original).]

The Committee only adds to the injustice perpetrated against Applicant by

maintaining the rejections of record as it continues citing Dr. Souw's biased views

against Applicant. Applicant once again strenuously protests this unfair treatment and

demands that the rejections in the present application be withdrawn immediately so that

this case can be allowed to finally issue.

Examiner Souw's Biased Views Adopted by the Committee are Further Demonstrated by Citation to His Own Work

The genuine conflict of interest that surrounds the questionable employment

history of Dr. Souw is not the only source of bias he brings to this case. Dr. Souw also

demonstrates extreme bias by citing two of his own technical papers published in the

journal *Physica* to support the rejection of Applicant's claims on theoretical grounds.

This procedural miscue is inherently unfair for two obvious reasons.

First, the Committee fails to show that the journals in which Dr. Souw's technical

papers appear are any more "scientifically qualified" with appropriate review process

than the journals that published Applicant's papers. Yet the Committee gives Dr.

Souw's papers the "credibility that peer-reviewed articles have" and refuses to bestow

the same credibility on Applicant's peer-reviewed journal articles. [See, for example,

page 5 of the Committee's May 19, 2004 Office Action in U.S. App'n Ser. No.

09/362,693] The Committee's reliance on Dr. Souw's papers merely illustrates an

obvious double standard and demonstrates once again its bias against Applicant in

failing to fairly consider his experimental evidence published in prestigious journals as

scientifically qualified, which evidence far outweighs the scant evidence produced by Dr. Souw. This double standard is but another example of the Committee's arbitrary and capricious handling of Applicant's cases.

Second, the Committee's reliance on the views of Dr. Souw based on citation of his own technical papers against Applicant is inherently unfair since Dr. Souw is no longer an impartial judge. How can the Examiner claim to be unbiased in response to arguments criticizing his own technical papers? The answer is obvious: he can't.

In any case, now that the Committee has relied upon Dr. Souw's own scientific research to support its rejections, Applicant is entitled to know from the Committee certain details of the Examiner's background, including a complete disclosure of his technical education and past work experiences. The Committee's steadfast refusal to disclose that relevant information only provides further basis for overturning its rejections.

In a previous Office Action, the Committee tried, but failed, to rationalize why Dr. Souw should be allowed to cite without scrutiny his own technical papers against Applicant:

> Applicant note[s] the involvement of Examiner Bernard Souw in the examination of another of his applications, and that Examiner Souw had previously worked for Brookhaven National Labs. Two things are thus pointed out. First, examiners are allowed, and even encouraged, to consult other examiners on matters of science. Dr. Souw is the author of the attached Appendix. While originally written for Serial No. 09/513,768, the Appendix is considered relevant to the present application for reasons stated below. Second, the employment history of examiners, including those acting in a consulting role, is irrelevant to the examination thereof, except where there is a genuine conflict of interest. [See April 14, 2004 Office Action at p. 4 in U.S. App'n. Ser. No. 09/008,947]

The first point—that the PTO generally encourages consultation with other Examiners—is not even in dispute and is therefore irrelevant. The present objection to the Committee's consultation of Dr. Souw is his obvious bias in citing papers he authored, which requires that he critically analyze and respond to criticisms of his own work.

The PTO's second point—that the employment history of Examiners is only relevant when there is a "genuine conflict of interest"—is a backward standard that defies common sense.[117] As Applicant aptly demonstrated above, it was only after he was forced to conduct his own investigation into Dr. Souw's relevant employment history—because the Committee improperly withheld that information—that Applicant was then able to demonstrate the existence of a genuine conflict in this case. It would have been impossible to demonstrate that conflict had Applicant not known the Examiner's relevant employment history involving his ongoing ownership and operation of BMS Enterprise and, apparently, the Committee would have liked to keep it that way.

In any case, now that Applicant has satisfied the Committee's "genuine conflict of interest" requirement, the Committee is obligated under its own backward standard to disclose the complete nature and scope of Dr. Souw's employment history so that a full determination can be made regarding the existence of other such conflicts.

Demand for Information and Redress

Applicant believes that the totality of events documented above are highly relevant to the PTO's examination of all of BlackLight's patent applications and accurately describe the detrimental effects that examination has had on Applicant's patent rights. These events further demonstrate the PTO's failure to provide adequate safeguards to the interests of Applicant, including fair and expeditious examination, as contemplated by the Federal Circuit in its June 28, 2002 Decision. Applicant therefore respectfully demands that the PTO provide certain information and redress, including:

1) identification of all Examiners or other PTO personnel who were consulted, or otherwise provided input, in the examination of BlackLight's applications;

2) identification of all other persons from outside the PTO who were consulted, or otherwise provided input, in the examination of BlackLight's applications;

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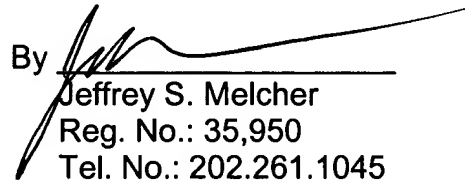
[117] Applicant disputes that a genuine conflict of interest is actually necessary to show bias—even the appearance of a conflict should be sufficient to taint the views expressed by Dr. Souw. This point is moot, however, since genuine conflicts of interest based on Dr. Souw's outside business activities have been shown, which conflicts have fatally infected Dr. Souw's biased views adopted by the Committee.

3) identification of all PTO officials responsible for withdrawing BlackLight's five allowed applications from issuance and a complete disclosure of the facts and circumstances surrounding that withdrawal action;

4) identification of all outside sources of information who may have precipitated, or otherwise contributed to, the PTO withdrawing BlackLight's five allowed applications from issuance and a complete disclosure of the facts and circumstances surrounding those actions;

5) a complete disclosure of the facts and circumstances surrounding the removal of Examiner Langel from examining BlackLight's applications and the transfer those cases to a new Examiner, including, but not limited to, identification of all persons involved in those actions;

6) immediate reinstatement of Examiner Langel to his position as the Examiner of record in all BlackLight applications to which he had been previously assigned;

7) the information sought above in connection with the questionable statements made by Examiner Wayner in the '180 application;

8) the information sought above in connection with Dr. Souw's conflict of interest in owning and operating BMS Enterprise while assigned by the PTO to examine and reject BlackLight's pending patent applications;

9) the examination and issuance of all allowable BlackLight applications in accordance with the above-mentioned representations and agreements made at the February 11, 2003 Interview; and

10) as a matter of equity, the immediate issuance, without further examination, of all five of BlackLight's withdrawn patent applications due to the PTO's failure to provide the safeguards to the interests of Applicant, including fair and expeditious further examination, as contemplated by the Federal Circuit in its June 28, 2002 Decision.

Conclusion

For the foregoing reasons, Applicant respectfully submits that the subject application fully satisfies the legal requirements of 35 U.S.C. §§ 101 and 112, first paragraph, and is therefore in condition for allowance. A Notice to that affect is earnestly solicited.

Respectfully submitted,
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Journal and Book Publications

107. R. L. Mills, "Maxwell's Equations and QED: Which is Fact and Which is Fiction," Physica Scripta, submitted.

106. R. L. Mills, "Exact Classical Quantum Mechanical Solution for Atomic Helium which Predicts Conjugate Parameters from a Unique Solution for the First Time," Foundations of Science, submitted.

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104. R. L. Mills, Y. Lu, M. Nansteel, J. He, A. Voigt, W. Good, B. Dhandapani, "Energetic Catalyst-Hydrogen Plasma Reaction as a Potential New Energy Source," Division of Fuel Chemistry, Session: Advances in Hydrogen Energy, 228th American Chemical Society National Meeting, August 22–26, 2004, Philadelphia, PA.

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84. R. L. Mills, P. Ray, J. Dong, M. Nansteel, R. M. Mayo, B. Dhandapani, X. Chen, "Comparison of Balmer α Line Broadening and Power Balances of Helium-Hydrogen Plasma Sources," Braz. J. Phys., submitted.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re <u>PATENT APPLICATION</u> of
Inventor(s): Mills

Group Art Unit: 1754

App'n Ser. No.: 09/110,694

Examiner(s): Kalafut for the
Secret Committee

Filing Date: 07/07/1998

Title: REACTOR FOR PREPARING HYDROGEN COMPOUNDS

*   *   *   *   *

March 8, 2005

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Attached are PTO/SB/O8B forms listing the enclosed documents. Copies of the enclosed documents are attached to this Information Disclosure Statement and/or to the Attachments to the Response filed herewith.

If necessary, please accept this Information Disclosure Statement under Rule 97(c) and charge the requisite Rule 17(p) fee to our Deposit Account No. 50-0687 under Order No. 27462/**62-226** for which purposes this paper is submitted in duplicate.
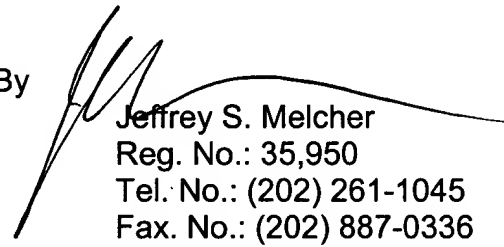
This information disclosure statement is intended to be in full compliance with the rules, but should the Examiner find any part of its required content to have been omitted, prompt notice that effect is earnestly solicited, along with additional time under Rule 97(f), to enable Applicant to comply fully. Consideration of the foregoing and enclosures plus the return of a copy of the herewith PTO/SB/08A and B forms with the

Examiner's initials in the left column per MPEP 609 along with an early action on the

merits of this application are earnestly solicited.

Respectfully submitted,
Manelli Denison & Selter PLLC

By

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Substitute for form 1449B/PTO	*Complete if Known*	
	Application Number	09/110,694
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Filing Date	07/07/1998
	First Named Inventor	Mills
	Group Art Unit	1745
(use as many sheets as necessary)	Examiner Name	Kalafut
Sheet 1 of 1	Attorney Docket Number	

OTHER PRIOR ART — NON PATENT LITERATURE DOCUMENTS			
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		Souw, Bernard, "Coherent Telescope array with self-homodyne interferometric detection for optcal communications," Opt. Eng. 42(11) 3139-3157 (Nov. 2003); U.S. Department of Commerce, Summary of Ethics Rules, USPT, 2000; October 15, 2004 E-mail to Examiner Wayner (Attachment S)	
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Coherent telescope array with self-homodyne interferometric detection for optical communications

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Abstract. The performance of a coherent telescope array (CTA) as an optical communications receiving system is analyzed with regards to the benefits and disadvantages in comparison to monolithic large-aperture single telescopes and conventional photon bucket systems, especially in terms of background photons. The bit error rates for differential phase-shift keying (DPSK) and binary pulse position modulation (BPPM) schemes are derived, the former using self-homodyne interferometry as a novel demodulation technique, in which the background photons interact incoherently. The possibility of further dividing the receiver's aperture into $N > 2$ smaller subtelescopes is explored, and its adaptability for implementing the N binary phase-shift keying (N-BPSK) technique with optical code division multiplexing (OCDM) is discussed. An N-CTA receiver system with an N-BPSK/OCDM technique is envisioned not only to achieve multiterabit per second data transfer capability, but also to adapt a novel noise suppression technique based on photon correlations, which would render a need for expensive and complicated adaptive optics obsolete. Further combined with significant reduction in weight and overall costs, an N-CTA system with an N-BPSK/OCDM technique could serve in deep space communications as well as in defense to achieve information dominance in the battlefield. © *2003 Society of Photo-Optical Instrumentation Engineers.* [DOI: 10.1117/1.1612512]

1 Introduction

Optical communication receivers having diffraction-limited fields of view (FOV) are known to have important advantages over nondiffraction-limited receiver systems.[1,2] These advantages include higher antenna gain, efficient background suppression due to small FOV, and compatibilities with state-of-the-art optical amplifiers, such as Er-doped fiber amplifiers (EDFAs), in-line fiber optic Fabry-Perot interferometers (FFPIs), and other recent developments in fiber optic devices and thin-film optical waveguide integrated circuits. However, implementation of diffraction-limited designs in large telescope apertures of 1 m diam or larger is technically challenging. A 2-m aperture can here be tentatively given as technical limit.[3] Quasi-diffraction-limited images can also be obtained using conventional adaptive optics (AO). However, even with AO correction, single telescope mirrors are practically limited to about 5 m diam.[4] Furthermore, AO systems for large telescopes are quite costly.

A viable alternative is to put a multiple of small- or medium-sized diffraction-limited subtelescopes together and add their signals coherently to form a coherent (receiver) telescope array (CTA). Such a receiver system has the advantage of a diffraction-limited FOV, while achieving signal photon collection capacity of very large aperture telescopes. Due to smaller mirror size, a CTA system is significantly lower in both cost and weight compared to conventional large aperture monolithic telescopes of equivalent photon collecting capacity. For use in space and mobile systems, smaller telescopes are more easily stored in launch and transport vehicles, and are more easily deployable from their storage than their single large aperture counterparts.

A CTA is particularly interesting for use with the differential phase-shift keying (DPSK) technique demodulated by self-homodyne interferometry (SHI). This DPSK/SHI technique has an inherent advantage owing to a time delay applied to one of the interferometer arms, which causes the background (BG) photons to interact incoherently. Such a time delay is always longer than the coherence time of the BG photons, since the optical filter bandwidth being used is always larger than the data rate to prevent filter ringing. The advantage is unique only to optical communications using the DPSK/SHI technique, and is not commonly shared by the astronomical version,[4-8] in which both the signal and background photons interact coherently, despite the extremely short coherence length.[9]
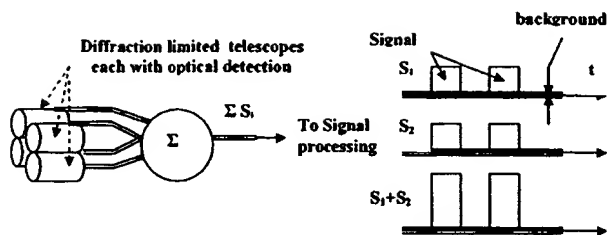
Fig. 1 Direct detection of BPPM signal.

$(=\langle E_S\rangle)$, so that the sum signal $E_\sigma=\langle N \cdot E_S\rangle$ is simply equal to $N \cdot \langle E_S\rangle$. Similarly, the total background E_β is simply a sum of the individual background counts E_B, i.e., $E_\beta=\langle N \cdot E_B\rangle=N \cdot \langle E_B\rangle$. The calculation of the bit error rate (BER) is straightforward, and is performed without taking account of optical amplification and other systems' gain and/or loss, since these factors are commonly shared in the number of photon counts effectively received by each receiver involved.

Whereas the larger diffraction-limited acceptance angle of smaller telescopes relieves the need for adaptive optics, and the SHI technique automatically cancels out phase fluctuations that are equally shared by the interometer arms, the CTA offers a further potential for compensating unequally shared background noise originating from atmospheric turbulence and scintillation, optical amplifiers, detector dark currents, etc., by a simple, low-cost correlation technique. This novel technique is adapted and modified from stellar interferometry,[9] and is briefly outlined in Appendix H in Sec. 15. Feasibility studies and research and development are still needed before this new and promising technology can be established.

The PSK/SHI modulation scheme is particularly adaptable to N-BPSK/optical code division multiplexing (OCDM), described in Appendix I in Sec. 16. In a further combination with wavelength division multiplexing (WDM), the N-BPSK/OCDM/WDM technique has recently demonstrated the capability of multiterabit per second data rates.[10–12] A time gating used in the decoding scheme further cuts a steady state background significantly, rendering the system much less sensitive to strong background, even if the latter is in direct line of sight. Having all these advantages combined, the CTA not only is relevant for interplanetary communications, but also for free space optical communications in general, and eventually for use in unmanned aircrafts and in current efforts for achieving information dominance in the battlefield.[13]

2 Telescope Array with Incoherent Modulations

A telescope array with direct detection (DD) is illustrated in Fig. 1. This DD scheme serves as a reference for evaluating the performance of the DPSK/SHI method illustrated in Fig. 2. Here the detected signals from individual subtelescopes are added together incoherently to generate a sum signal. Assuming the N subtelescopes are identical, the expectation of the individual subsignal count is the same

Fig. 2 DPSK with self-homodyne interferometric (SHI) detection.

3 CTA with DPSK Signal Decoding by Self-Homodyne Interferometry

The coherent technique depicted in Fig. 2 is a DPSK scheme decoded by time-delayed self-homodyne Mach-Zehnder interferometry. Unlike conventional heterodyne and homodyne techniques, the proposed self-homodyne time-delay technique does not make use of any local oscillator, thus dispensing a need for a conventional optical phase-locked loop.[14] The conventional DPSK signal is demodulated by a modified Mach-Zehnder interferometer (MZI), which may be based on either fiber optics or planar waveguide integrated optics. Owing to its circular symmetry, a fiber optic MZI provides the best match to diffraction-limited delivery optics, resulting in low insertion loss. However, an integrated-optic interferometer is superior regarding mechanical integrity. Of course, a single monolithic telescope may be alternatively used in combination with an additional beamsplitter that would incur an additional 7 to 11% loss (estimated from various manufacturer's data sheets for 1×2 single- and multimode beamsplitters and fiber couplers, e.g., typical excess loss ≤ 0.35 dB, or $< 7.7\%$).

As is already known, the DPSK encoding introduces a 180-deg phase shift relative to the preceding wavetrain for representing the bit symbol 0, and a 0-deg phase shift for the bit symbol 1, at time intervals T (signaling time). In the transmitter part, messages can be encoded using an electro-optic phase modulator (EOPM) or a resonant cavity phase modulator (RCPM)[15] capable of high bit rates of up to 1 to 10 Gbps or even higher.

For decoding, the signal wave train in one interferometer arm is delayed with respect to the other by the signal interval T, which must be held meticulously accurate and constant. A small deviation would prevent a complete extinction in the destructive interference signal and generate a large amount of noise.[16] Such a misadjustment can be corrected by introducing a small corrective time delay. In practice, this extinction condition can be utilized for phase stabilization, i.e., by maintaining the difference between the outputs of the two complementary detectors $|D1-D2|$, always at maximum, as depicted in Fig. 3.

In principle, the proposed SHI demodulation is technically much simpler than the conventional homodyne technique using a local oscillator as phase reference, which requires a synchronization bit from the transmitter (SyncBit technique[17,18]) and a Costas phase-lock/feedback loop[14] to control and synchronize the phases. In DPSK this reference phase is provided and carried by the signal itself. However, the demand on phase accuracy ωT imposed on the time delay T is still very high,[17] so all delay lines should be fiber

Coherent Receiver Telescope Array
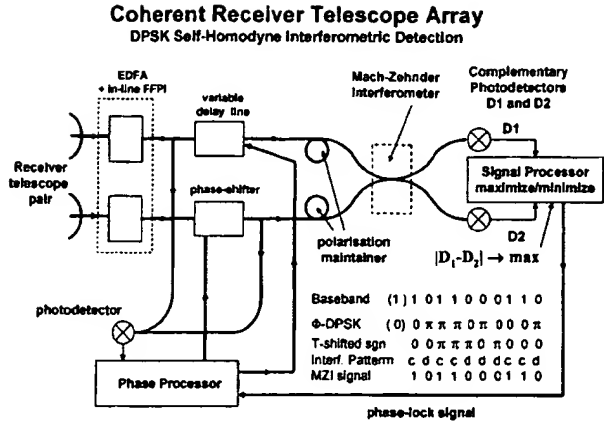### DPSK Self-Homodyne Interferometric Detection

Fig. 3 Schematics of a $N=2$ CTA system with DPSK-SHI demodulation.

optic or solid state based and subjected to a strictly controlled environment.

4 Bit Error Rate Calculations

4.1 Incoherent Summation of Pulse-Position Modulated Signals

As described in Appendix B in Sec. 9, photodetection by a square-law detector integrates the signal power $P_S(t)$ over one bit interval $(0-T)$, which then yields

$$\langle E_S \rangle = K_S \cdot h\upsilon, \tag{1}$$

where K_S is the signal count [photons/sec], and $h\upsilon$ is the energy per photon (h is Planck's constant and υ is the wave frequency).

The background noise is assumed to be a white noise (see Appendix A in Sec. 8). As further detailed in Appendix B in Sec. 9, the noise energy per bit symbol interval integrated over the filter bandwidth $\Delta\omega = B \geqslant 2/T$ is

$$\langle E_B \rangle = K_B \cdot h\upsilon, \tag{2}$$

where K_B is the background photon count received within a time interval $t = 0 - T$.

For simplicity, a proportionality factor that provides a proper link between E_B and K_B, determined by the spectral sensitivity and quantum efficiency of the detector, is omitted.

Summing up postdetection signals from two subtelescopes incoherently, we obtain

$$\langle E_{\sigma,\beta} \rangle = \langle N \cdot E_{S,B} \rangle = 2\langle E_{S,B} \rangle. \tag{3}$$

As detected by a square-law detector, the signal appears to be sitting on a background (see Appendix B in Sec. 9), so an integration over one bit interval yields

$$\langle E_{N=2} \rangle = \langle 2E_S + 2E_B \rangle = h\upsilon \cdot (2K_S + 2K_B). \tag{4}$$

4.2 BER Calculations for BPPM Single and Dual Receivers

In the shot-noise limit ($P_S \gg$ thermal and electric/circuit noise), the probability of obtaining a count k for a stochastic process having an expectation value of K has a Poisson distribution

$$P(k,K) = [K^k/k!] \cdot \exp(-K). \tag{5}$$

The BER can be calculated as the probability that one Poisson variate (k_1) containing signal plus noise energy is smaller than another Poisson variate (k_2) containing the noise energy alone,[18] i.e.,

$$PE_1 = \sum_{k_1=0}^{\infty} \sum_{k_2=k_1}^{\infty} P[k_1,(K_S+K_B)] \cdot P(k_2,K_B) \cdot \gamma(k_1 k_2), \tag{6}$$

where $\gamma(k_1 k_2) = 0.5$ if $k_1 = k_2$ and $\gamma(k_1 k_2) = 1.0$ otherwise, to account for the case that if k_1 is equal to k_2, a decision has still to be made whether it belongs to a count containing signal plus energy or just the noise energy alone, each decision sharing the same weight of 0.5.

While Eq. (6) is valid for a single measurement, summing up the outputs of two subreceivers results in a bit error probability of

$$PE_2 = \sum_{k_1=0}^{\infty} \sum_{k_2=k_1}^{\infty} P[k_1,(2K_S+2K_B)] \cdot P(k_2,2K_B)$$
$$\cdot \gamma(k_1 k_2). \tag{7}$$

The BER for a single telescope system ($N=1$) calculated according to Eq. (6) and for a dual telescope CTA according to Eq. (7), are plotted in Figs. 4(a), 4(b), and 4(c) as thin-lined and bold-lined curves, respectively, as functions of signal counts varying from 0 to 20 photons/bit/channel with background photon count K_B as a parameter.

4.3 DPSK Demodulation by Time-Delayed Self-Homodyne Interferometry

For interferometer analysis, it is more appropriate to use the beam intensity $I(t)$ due to its direct relation to the electric field vector $\mathcal{E}(t)$ of the electromagnetic waves undergoing the interference process. The relevant notations used here are described in more detail in Appendix C in Sec. 10. Unlike in previous incoherent direct detection, signals received by two subtelescopes are added in a coherent manner. We thus have the wave vectors (or more rigorously, phasors, see Appendix A in Sec. 8) $|\mathcal{E}_S| = \sqrt{I_S}$ and $|\mathcal{E}_S| = \sqrt{I_B}$ before the interferometer beamsplitter, and $\sqrt{(I_S/2)}$ and $\sqrt{(I_B/2)}$ per interferometer arm after the 50/50% beamsplitter/combiner. Each of the photodetectors D_1 and D_2 receives a superposition of an undelayed wave $\sqrt{(I_S/2)}$ $+ \sqrt{(I_B/2)} \cdot \exp i\varphi_1$, and a delayed wave $\sqrt{(I_S/2)} \cdot \exp i\omega T$ $+ \sqrt{(I_B/2)} \cdot \exp i(\omega T+\varphi_2)$. In case a symbol 0 is being sent, referring to a 0-deg change in phase after a signaling interval T, the delayed signal wave $\sqrt{(I_S/2)} \cdot \exp i\omega T$ has the same phase as the undelayed signal wave $\sqrt{I_S/2}$, and the

superposition results in a constructive addition of the two signal wave vectors (phasors) $\sqrt{(I_S/2)}$ to form $\sqrt{I_S}$. On the other hand, a time delay of T applied to the background photons pushes the interfering photons out of their coherence length, since T is always larger than the coherence time of the noise ($\tau_{coh} \approx 1/\text{receiver bandwidth} \leqslant T/2$).

In case of constructive interference (see Appendix D in Sec. 11), a superposition of signal and BG intensities yields $\sqrt{(I_S/2)} + \sqrt{(I_B/2)} \cdot [\exp i\varphi_1 + \exp i(\omega T + \varphi_2)]$, and the average intensity received by one of the square-law detectors is then given by (with $I = |\mathcal{E}|^2$),

$$
\begin{aligned}
I(D_1) &= \{2\sqrt{I_S/2} + \sqrt{I_B/2} \cdot [\exp j\varphi_1 + \exp j(\omega T + \varphi_2)]\} \\
&\quad \cdot \{2\sqrt{I_S/2} + \sqrt{I_B/2} \cdot [\exp -j\varphi_1 + \exp -j(\omega T + \varphi_2)]\} \\
&= 2 \cdot I_S + I_B + 2 \cdot I_B \cdot \langle \cos(\omega T + \varphi_2 - \varphi_1) \rangle \\
&\quad + 2\sqrt{I_S} \cdot I_B \cdot \{\langle \cos \varphi_1 \rangle + \langle \cos(\omega T + \varphi_2) \rangle\} \\
&= 2 \cdot I_S + I_B.
\end{aligned} \tag{8}
$$

Since ωT is a constant, all time-averaged quantities become essentially zero, owing to the statistical randomness of φ_1 and φ_2. For a destructive interference case [corresponding to Eq. (39)] the signal part of Eq. (8), i.e., $2 \cdot I_S$, simply vanishes, but the incoherent background I_B remains intact. [In Eq. (8) and henceforth, $\sqrt{(I_S/2)}$ will be written as $\sqrt{I_S/2}$].

For comparison at the same bit rate, it is conventional to assign to the DPSK a bit energy twice as high as in BPPM, since the intensities are integrated over a time period twice as long as in BPPM (see Appendix A in Sec. 8). Hence, in place of Eq. (8), we now have $4 \cdot I_S + 2 \cdot I_B$, or alternatively, in terms of photon numbers, $4 \cdot K_S + 2 \cdot K_B$.

In spite of close similarity, this result is to be distinguished from the fringe intensity distribution in a Young's double slit interference.[19] Since no beamsplitter/coupler is thereby used, the Young's double slit corresponds to a misaligned MZ interferometer, where an intensity of $4 \cdot I \cos^2 \delta/2 = 4 \cdot I$ is measured at the fringe peak, with δ being a phase difference due to unequal optical path lengths between the two slightly tilted beams. An average over the sinusoidal intensity distribution along a coordinate axis must be performed to rigorously demonstrate an energy or photon conservation. This brings a factor of 1/2 to the total fringe intensity.

In a MZI, a beamsplitter/coupler is used. This effectively introduces a factor 1/2 in terms of photon number, whereas another factor 2 is introduced to compare with a 50% BPPM case. In a perfectly aligned MZI, there is no interference fringe comparable to Young's double slit experiment, so averaging or integrating over the spatial extent of the diffraction intensity results in a factor of unity. As discussed in Appendix D in Sec. 11, signal beam divergence does not change the conditions for constructive or destructive interference in the complementary outputs, as long as the MZI mirrors are perfectly aligned.

4.3.1 DPSK-SHI demodulation using a single detector

If only one detector D_1 or D_2 is used, there is no possibility to compare the received counts with any known standard, except with respect to a threshold count that is to be previously determined and held constant during the demodulation. In fact, the received message is exactly like in on-off keying (OOK) modulation, but with $4 \cdot K_S$ as the signal count and $2 \cdot K_B$ as the background count. The BER is then calculated according to Ref. 20,

$$
\begin{aligned}
\text{BER}_2 = 0.5 \cdot \sum_{k=0}^{k_T} \gamma P[k, (4K_S + 2K_B)] \\
+ 0.5 \cdot \sum_{k=k_T}^{\infty} \gamma P[k, (2K_B)],
\end{aligned} \tag{9}
$$

where $\gamma = 0.5$ for $k = k_T$, and $k = 1$ otherwise.[20]

In Eq. (9), K_S and K_B are the number of signal and background photon counts received, respectively, and k_T is a predetermined threshold, which makes the BER minimum[20,21]

$$
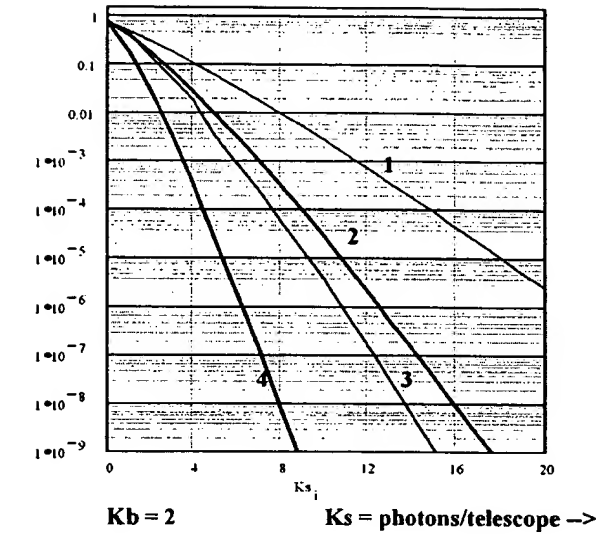k_T = (4 \cdot K_S)/\ln[1 + 4K_S/(2K_B)]. \tag{10}
$$

The BER results are plotted in Figs. 4(a), 4(b), and 4(c), thin-lined curve 3, as a function of K_S with K_B as a parameter. The superiority of the DPSK-SHI demodulation over the conventional BPPM is obvious, even with only one single detector, i.e., without making use of the complementary signal.

4.3.2 DPSK-SHI demodulation using two complementary detectors

For complementary detection using dual detectors D_1 and D_2, there is now a good possibility to compare the photon count received by one detector with that received by the complementary detector. The probability of error is therefore equal to the sum of all probabilities that a Poisson variate k_1 containing signal and noise energy is smaller than the Poisson variate k_2 containing the noise energy alone[20,21]:
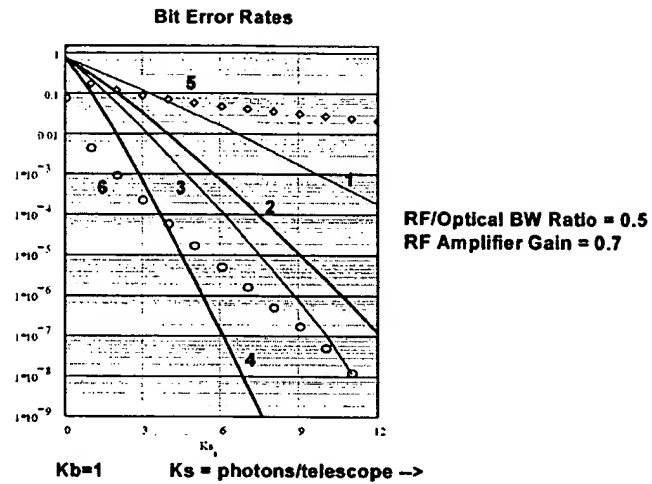
$$
\begin{aligned}
\text{BER}_2 = \sum_{k_1=0}^{\infty} \sum_{k_2=k_1}^{\infty} P[k_1, (4K_S + 2K_B)] \cdot P(k_2, 2K_B) \\
\cdot \gamma(k_1 k_2),
\end{aligned} \tag{11}
$$

where $\gamma(k_1 k_2) = 1/2$ for $k_1 = k_2$, and $\gamma(k_1 k_2) = 1$ else.[20] The factor $\gamma(k_1 k_2) = 1/2$ accounts for the fact that, in the case k_1 is equal to k_2, no decision is better than the other, both having a 50/50% chance of error. The second term on the right-hand side of Eq. (13) is the probability that k_2 gives a lower reading than k_1. Equation (11) can be written as
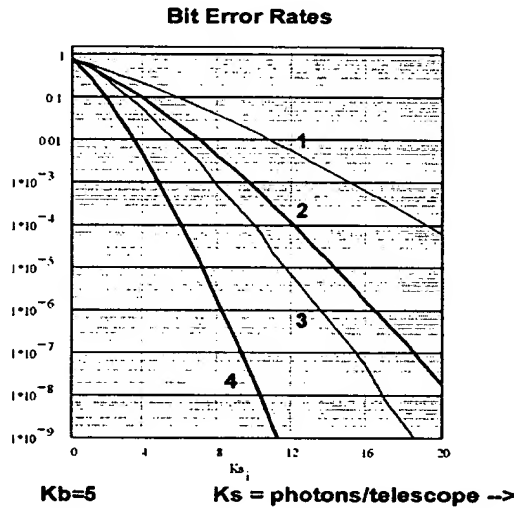
Bit Error Rates

Kb = 2 **Ks = photons/telescope —>**

Curve 1: BPPM Single Telescope
Curve 2: BPPM Dual Telescope
Curve 3: DPSK Single Detector
Curve 4: DPSK Complemenary Detectors

(a)

Bit Error Rates

RF/Optical BW Ratio = 0.5
RF Amplifier Gain = 0.7

Kb=1 **Ks = photons/telescope —>**

Curve 1: BPPM Single Telescope
Curve 2: BPPM Dual Telescope
Curve 3: DPSK Single Detector
Curve 4: DPSK Complemenary Detectors
Curve 5: DFSK Correlation-Type RF Decoding ($\Diamond$ diamonds)
Curve 6: DFSK Square Law RF Decoding ($\bigcirc$ circles)

(c)

Bit Error Rates

Kb=5 **Ks = photons/telescope —>**

Curve 1: BPPM Single Telescope
Curve 2: BPPM Dual Telescope
Curve 3: DPSK Single Detector
Curve 4: DPSK Complementary Detectors

(b)

Fig. 4 Bit Error Rates for DPSK-SHI and BPPM for (a) $Kb=2$, (b) $Kb=5$, and for (c) DPSK-SHI, DFSK, and BPPM for $Kb=1$.

$$BER_2 = \sum_{k_1=0}^{\infty} \sum_{k_2=k_1+1}^{\infty} P[k_1,(4K_S+2K_B)] \cdot P(k_2,2K_B)$$

$$+ 0.5 \cdot \sum_{k_1=0}^{\infty} P[k_1,(4K_S+2K_B)] \cdot P(k_2,2K_B). \quad (12)$$

Throughout this article all receiver sensitivities are referred to a standard BER of 10^{-6}.

Comparison of curve 4 (DPSK) to curve 2 (BPPM) in Figs. 4(a), 4(b), and 4(c) consistently shows a general superiority of CTA/DPSK-SHI systems over a conventional dual telescope BPPM system with direct detection, thereby achieving a sensitivity of 12 photons/bit total (or 6 photons/telescope) for DPSK-SHI with complementary detection (curve 4) under a background count of $K_B=2$, in comparison to 25 photons/bit (total) for incoherent BPPM detection

(curve 2). Even a noncomplementary DPSK-SHI using only a single detector (curve 3) already shows a sensitivity (22 photons/bit), which is significantly better than the BPPM direct detection (curve 2). Results for a background count of $K_B = 5$ are plotted in Fig. 4(b), showing a sensitivity of 16 photons/bit for DPSK with complementary SHI detection, in comparison to 33 photons/bit for BPPM detection.

Figure 4(c) shows for $K_B = 1$ the BER curves for a single telescope BPPM (curve 1), a dual telescope BPPM (curve 2), DPSK-SHI single detection (curve 3), and DPSK-SHI dual/complementary detection (curve 4). The two additional curves 5 and 6 are calculated for a dual telescope with differential frequency shift keying (DFSK) not specifically addressed in this article, but described in detail in a previous work.[1] As briefly illustrated in Appendix I in Sec. 16, the same time-delay technique as previously used in DPSK is here applied to DFSK modulation, however without interferometry, making use of the nonlinear property of an optical square-law detector to generate optical frequency mixing and retrieve the frequency-shifted signal modulation, just like in a classical heterodyne/homodyne. Similar to the previous DPSK-SHI, this special DFSK demodulation is also self-homodyning (without an auxiliary local oscillator). In analogy to the conventional heterodyne technique, the noise is effectively amplified by the signal, here acting as a local oscillator. It is therefore not surprising that the corresponding BER, curves 5 and 6, do not decrease rapidly enough with increasing signal counts.

Curve 5 (diamonds) corresponds to a DFSK self-homodyne detection using correlation-type rf decoding[22] to process the difference frequency signal, whereas curve 6 (circles) refers to DFSK self-homodyne using a square-law rf detector for decoding the difference frequency signal. Unlike correlation decoding, the square-law decoded rf signal output—and hence the BER—depends sensitively on the rf amplifier gain being used ($G = 0.7$ for square-law rf decoding, curve 6). For both rf decoding techniques, the BER depends on the ratio of rf filter bandwidth to optical filter bandwidth, which is taken to be 0.5 for both DFSK BER curves shown in Fig. 4(c). The results shown in Fig. 4(c) indicate that the special version of DFSK, while sharing the same technical simplicity, does not perform as well as the previous DPSK with SHI demodulation.

5 Comparison to Conventional Single Telescope Systems

BER comparisons with single large aperture telescopes using conventional decoding schemes are presented in this section. A few reference schemes selected are the conventional direct detection BPPM, Manchester encoding, binary phase shift keying (BPSK) with conventional heterodyne detection using a local oscillator, and conventional frequency shift keying (FSK) with heterodyne detection, also using a local oscillator. The BERs for the selected reference cases are computed for an ideal condition (negligible background noise $K_B \ll K_S$ signal), and compared to the shot-noise limited formulas ($P_S \gg$ thermal and circuit noise) derived in the present work. They are computed either for $K_B = 0$ or for $K_B = 0.1$, the latter assumed to circumvent a

numerical singularity in the computer program, and is a condition slightly worse than, but close to, the ideal condition. Consequently, comparisons are better taken at large values of $K_S (\gg 0.1)$. A further comparison with equivalent single telescope systems under the presence of strong background $K_B \approx K_S$ is given in Sec. 6.

5.1 PPM—Direct Detection

The BER for Manchester PPM[21] and BPPM[21] is given by

$$BER = Q(\sqrt{SNR}), \tag{13}$$

where $Q(x)$ is the Gaussian Q function:

$$Q(x) = 1 - \mathrm{erf}(x) = 1/\sqrt{2}\pi \int_x^\infty \exp(-u^2/2)du = 1 - \mathrm{erf}(x),$$

with $SNR \approx K_S^2/[K_S + 2K_B)$, as given in Ref. 20 (see also Appendix B in Sec. 9).

For proper comparison with a dual channel CTA receiver, the number of signal photons is to be doubled. In the ideal case ($K_B \ll K_S$), we thus have $SNR \approx 2 \cdot K_S$, and hence

$$BER \approx Q[\sqrt{(2K_S)}]. \tag{14}$$

This is the same as the formula given in Ref. 16 for direct detection with Gaussian statistics, as well as for multimode detection and for incomplete thermal noise suppression of differential phase shift keying with optical preamplification (OP-DPSK), all in the ideal case ($K_B \rightarrow 0$).

5.2 Binary Phase Shift Keying

The BER for BPSK under conventional heterodyne detection is given in Ref. 20 as:

$$BER = Q(\sqrt{SNR}) = 1 - \mathrm{erf}(\sqrt{SNR}), \tag{15}$$

with $SNR = n_S T/(1 + \alpha N_0)$. In the ideal case, while taking into account the doubled photon counts for comparing with a dual telescope CTA, the expression for BER then yields

$$BER \approx Q[\sqrt{(2\ K_S)}], \tag{16}$$

which comes out to be the same as the BER for Manchester PPM in Eq. (14).

### 5.3 Noncoherent Frequency Shift Keying

Under conventional heterodyne detection using a local oscillator (LO), the BER is given in Ref. 21, BER $= 0.5 \exp(-E_S/2N_0)$, which in the ideal case and a doubled photon count becomes

$$BER \approx 0.5 \exp(-2K_S). \tag{17}$$

This is the same as the formula used in Ref. 16 for FSK modulation with conventional heterodyne detection and for BPPM with direct detection.

For clarity, reference curves according to Eqs. (13) through (17) are plotted by dots/symbols in Fig. 5. As can be seen, the BER for Manchester and BPPM without dou-

Ks = photons/telescope ➜
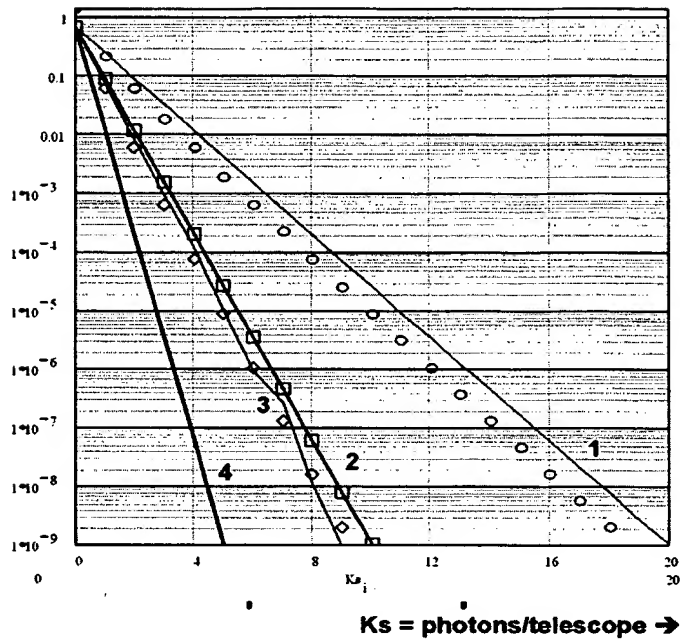
Curve 1: BPPM Single Telescope (Kb=0)
Curve 2: BPPM Dual Telescope (Kb=0)
Curve 3: DPSK Single Detection (Kb=0.08)
Curve 4: DPSK with Complementary Detection (Kb=0)

O Heterodyne BPSK with LO – Single Telescope (Kb=0)
◊ Heterodyne BPSK with LO – Doubled Photon Counts (Kb=0)
□ Non-Coherent FSK (Kb=0)

Fig. 5 Comparison with conventional methods.

bling the photon count [Eq. (13), marked O in Fig. 5), which is the same as BPPM with conventional heterodyne decoding [Eq. (16)], is close to the BER for a single telescope, according to Eq. (9) (curve 1). A small discrepancy between the two curves reflects the difference between the Poisson formula [Eq. (9)] and the Gaussian approximations [Eq. (13)]. The conventional FSK curve marked □ coincides with the BPPM curve for a dual telescope array (curve 2), whereas the conventional heterodyne BPSK curve marked ◊ coincides with the DPSK-SHI curve 3 using only one detector.

In all cases, the BER for DPSK-SHI using complementary detectors is 3 orders of magnitude (or more) better than the conventional modulation techniques, including the heterodyne techniques using local oscillators, although the total number of photon counts received is the same. We therefore may conclude, at least under the ideal condition ($K_B \ll K_S$), an $N=2$ CTA receiver with DPSK-SHI decoding performs better than an equivalent single telescope diffraction-limited system with conventional encodings.

6 Extension to $N=2^n$ Coherent Telescope Array

Combining $N(=2^n)$ telescopes in an incoherent manner, as in the direct detection case, is straightforward. For a coher-

ent DPSK case, there are at least two ways for combining signals counts from a multiple of N subtelescopes into a single CTA receiver output.

The first method is to coherently bundle all the outputs from $N/2$ subtelescopes ($N=2^n$) to form one coherent optical path, e.g., using $N\times 1$ fiber optic couplers, or alternatively, by coherently combining the outputs from $N/2$ cascaded systems of planar waveguide interferometers, then superimposing with the coherent output from another bunch of $N/2$ subtelescopes to perform MZ interferometry. This first method is used in Appendix G in Sec. 14.

The second method is to interferometrically process every pair of signals received by the N subtelescopes, and then combine the $N/2$ outputs together to derive a final result. This method can be implemented using a conventional or a thin-film optical waveguide MZI. These two signal combination methods are not expected to yield significantly different results.

6.1 Combining N Subtelescopes in Direct Detection (BPPM) Scheme

The BER formula given by Eq. (9) can be extended to $N>2$ by scaling up the signal and background counts according to the extrapolation scheme $K_S \rightarrow N \cdot K_S$ and

Ks, Kb refer to BPPM (50% duty cycle)

Ks = 2   Kb = 2   Ksl = 1   Kbl = 1

Number of Subtelescopes —>
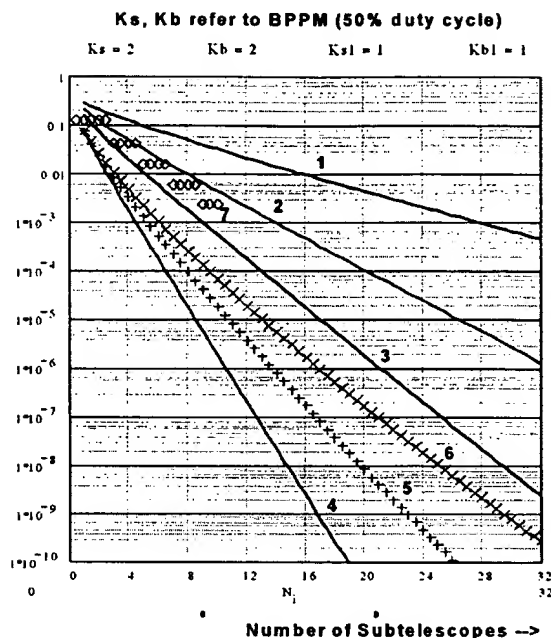
Curve 1: BPPM with Ks=1 and Kb=1 (no insertion and/or absorption loss)
Curve 2: BPPM with Ks=2 and Kb=2 (no insertion and/or absorption loss)
Curve 3: DPSK with Ks=1 and Kb=1 (no insertion and/or absorption loss)
Curve 4: DPSK with Ks=2 and Kb=2 (no insertion and/or absorption loss)
Curve 5: DPSK with Ks=2 and Kb=2 (7% absorption loss ~ - 0.3 dB per beam splitter)
Curve 6: DPSK with Ks=2 and Kb=2 (11% absorption loss ~ - 0.5 dB per fiber coupler)
Curve 7: ◇ BPPM Extrapolation for N ≥ 2 according to Table 1
Note: The curve for N=1 does not take account for loss due to additional beam splitter.

Fig. 6 Bit error rates for N-subtelescope CTA receivers.

$K_B \rightarrow N \cdot K_B$, which is appropriate for incoherent additions of output intensities as previously used in Eq. (9). The resulting BER as a function of number of subtelescopes N is shown in Fig. 6, curve 1, for $K_S = 1$ and $K_B = 1$ photons/bit/channel, and curve 2 for $K_S = 2$ and $K_B = 2$ photons/bit/channel.

This result is to be compared with another legitimate way of calculating the BER for N identical receivers, provided the probability of error (PE) for one receiver output is already known. The method is described in Appendix E in Sec. 12, and the results are shown in Table 1.

The behavior of BER as a function of N according to this alternative method, using a PE previously obtained for a single receiver with a signal count of $K_S = 2$ photons/bit/

channel and a background count of $K_B = 2$ photon/bit/channel, is shown in Fig. 6, curve 7 (diamonds). As can be seen, this second method of calculating BER for N incoherent receivers (or telescopes, or channels) agrees fairly well with the BER directly calculated from summing up the counts and making use of the conventional BER formula given by Eq. (9) (Fig. 6, curve 2).

Figure 6 shows for a signal count of $K_S = 2$ photons/bit/channel and a background count of $K_B = 2$ photon/bit/channel the BER values for DPSK-SHI (curve 4) and for direct detection of BPPM (curve 2). The results show an obvious superiority of the DPSK with interferometric detection over the incoherent BPPM in an N-element CTA receiver system.

6.2 Comparison of N-Telescope CTA with Single Large Aperture Telescope

Figure 6 also shows the BER for a DPSK-SHI system (curve 4) and a BPPM system (curve 2) as functions of N, both with $K_S = K_B = 1$ and $K_S = K_B = 2$ photons/bit/channel, respectively. To compare the BER achieved for the same number of photon counts/bit received, we find in Fig. 6 that the BER obtained for $(K_S = 2, K_B = 2)$ at $N = 2$ is exactly the same as that obtained for $(K_S = 1, K_B = 1)$ at $N = 4$, both representing the same total photon counts of 4 photons/bit received by all telescopes in the array. The same thing is found for $K_S = 1$, $N = 8$, and $K_S = 2$, $N = 4$. This property is

Table 1 Combination of N-telescope array in direct detection.

Number of telescopes	BER formula in terms of error probability for a single telescope (=PE)
1 and 2	PE
3 and 4	$3 \cdot PE^2 - 2 \cdot PE^3$
5 and 6	$10 \cdot PE^3 - 15 \cdot PE^4 + 6 \cdot PE^5$
7 and 8	$35 \cdot PE^4 - 84 \cdot PE^5 + 70 \cdot PE^6 - 20 \cdot PE^7$
9 and 10	$126 \cdot PE^5 - 420 \cdot PE^6 + 540 \cdot PE^7 - 315 \cdot PE^8 + 70 \cdot PE^9$

common for both BPPM and DPSK. We may thus conclude that there is no intrinsic advantage of increasing the number of subtelescopes in a CTA system using the same modulation scheme if a strong background is present (e.g., with the sun, moon, planets, and/or cloud within the receiver's FOV).

The BER plots in Fig. 6 are useful for making a quick estimate of how much the BER will improve by adding more subtelescopes into a CTA. It does not tell whether the CTA performs better or worse than a single monolithic telescope receiver having the same total aperture area. To that effect, three important factors have to be considered, i.e., 1. the effect of signal beam divergence, 2. the receiver's diffraction-limited FOV, and 3. the effect of signal beam divergence on the interference output of a MZI.

A receiver telescope is designed to intercept as many photons as possible, i.e., as large as what is permitted by the design conditions. On the other hand, a transmitter telescope is not primarily subjected to an aperture size constraint, but more directed to an optimal transmission of a given signal power. A reduced directional efficiency, or antenna gain (see Appendix F in Sec. 13) due to smaller transmitter aperture can be simply compensated by increasing the transmitter laser power. Therefore, a transmitter telescope diameter (D_{tr}) is normally designed as being (much) smaller than the receiver's aperture (D_{rec}).

For long range communications, the expanse of the signal beam at the receiver's location usually is much larger than the area occupied by the receiver system's physical aperture. Consequently, a proper comparison has to be made for a given transmitter offering the same signal and background power density $dP_{S,B}/d\Omega$ [Watts/steradian] at the location of the receiver. As detailed in Appendix F in Sec. 13, the signal and background power received by a subtelescope is proportional to the aperture area $\Delta A = R^2 \cdot \Delta\Omega$, where R is the communication link distance:

$$P_{S,B} = \int_{\Delta A/R^2} (dP_{S,B}/d\Omega) \cdot d\Omega \approx (dP_{S,B}/d\Omega) \cdot \Delta A/R^2.$$
$$(18)$$

For proper comparison, the total aperture area of the N subtelescopes, i.e., $\Delta A_N = N \times \pi D_{rec}^2/4$, with N being the number of subtelescopes in the array and D_{rec} their diameter, is to be taken as equal to that of a single telescope $\Delta A_0 = \pi D_0^2/4$, thus resulting in a comparison constraint, $D_{rec} = D_0/\sqrt{N}$.

Due to smaller aperture, both the signal and background power received by each subtelescope is reduced by a factor of $(D_{rec}/D_0)^2 = 1/N$. On the other hand, due to smaller telescope size, the diffraction-limited FOV of each subtelescope is increased. This increase of FOV has different impacts on the signal as compared to the background.

Background (BG) photons normally originate from an extended area of emitting surface, such as solar, lunar, and planetary disks, also cosmic nebula and/or atmospheric clouds. In such a case, the BG power received is increased by a factor of $(D_0/D_{rec})^2 = N$ (i.e., equivalent to an increased number of spatial modes $D_S > 1$, see Appendix F in Sec. 13). This cancels out the previous $1/N$ reduction due to smaller apertures, as described in more detail in Appendix

F. Thus, each of the N subtelescopes receives essentially the same BG power P_B, just as what is received by a monolithic large aperture diffraction-limited telescope.

On the other hand, owing to the much smaller transmitting aperture, the signal beam forms only a single spatial mode, i.e., the diffraction limited mode of the receiver's optics (see Appendix D in Sec. 11). Therefore, unlike the background power, the signal power does not increase with the larger diffraction-limited angle of a smaller subtelescope.

6.3 Self-Homodyne DPSK Demodulation by MZI

In a DPSK decoding with $N = 2^n$ subtelescopes, time-delayed interferometric superposition can be made only once. The remaining coherent superpositions are to be performed without time delay. As known from astronomical telescope interferometers, under a condition of zero time delay or equal optical path lengths, BG photons from the two interferometer arms add coherently on the superposition by a beam coupler, just like signal photons do, despite their extremely short coherence length.[9]

Consequently, a coherent superposition of two incident beams of equal intensities $I_{S,B}/2$ after recombination at the last beam coupler, without applying a time delay, yields (with bold letters denoting phased amplitude or phasor, see Appendix D in Sec. 11)

$$I_{S,B}(\text{coh}) = (\sqrt{\mathbf{I}_{S,B}/2} + \sqrt{\mathbf{I}_{S,B}/2})^2$$
$$= I_{S,B}/2 + I_{S,B}/2 + 2 \cdot (I_{S,B}/2) \cdot \cos\delta$$
$$= 2 \cdot I_{S,B} \cdot \cos^2 \delta/2 = 2 \cdot I_{S,B},$$
$$(19)$$

where δ is given by $\delta = (\Delta x/\lambda) \cdot 2\pi$, with λ being the photon wavelength and Δx the optical path difference between the two interferometer arms, which is essentially constant over the beam cross section (see Appendix D in Sec. 11). The phase difference δ for BG photons in case of zero time delay remains zero for all wavelengths.[9]

In most interferometer analyses, also in deriving Eq. (19), the light propagating in the interferometer arms is assumed to be a plane wave, whose cross section theoretically would expand to infinity. For diffraction-limited (or Gaussian) beams, the cross section remains confined throughout the entire propagation length, with a consequence that such a beam must have a finite divergence. However, as discussed in Appendix D in Sec. 11, this divergence does not change the value of δ in Eq. (2), which remains constant over the beam's cross section. Thus, the results derived for plane waves are also applicable to diffraction-limited or Gaussian beams. The only difference is the definition of power in terms of intensity, which can be easily adapted by taking the average intensity instead of the peak intensity on the axis of the Gaussian beam.

6.4 Comparison of N-CTA with SHI Decoding to Single Aperture System

For comparing the performance of an N-CTA SHI system with a single aperture system of the same total aperture, the number of signal photons received by each subtelescope is reduced by a factor N. However, due to larger FOV, the number of background photons received by each subtele-

Table 2 Signal and BG in single telescope, N-CTA, N-BPSK, and photon bucket.

Receiver system	Total signal photons	Total BG photons
Single/Monolithic Diff. Ltd.	$I_S \cdot T$	$I_B \cdot T$
N-CTA with BPPM encoding	$I_S \cdot T$	$N \cdot I_B \cdot T$
N-CTA with DPSK encoding	$I_S \cdot T$	$N \cdot (I_B/2) \cdot T$
Photon bucket with BPPM	$I_S \cdot T$	$N \cdot I_B \cdot T$
Photon bucket with DPSK	$I_S \cdot T$	$N \cdot (I_B/2) \cdot T$
N-BPSK/OCDM	E_S (pulse energy in δT)	$N \cdot I_B \cdot \delta T \approx I_B$

scope is the same as that received by the large aperture. Under such a condition, a procedure for coherent summation of signal waves of amplitude $\sqrt{(I_S/N)}$ and an incoherent addition of the background intensity I_B is described in Appendix G in Sec. 14.

Due to increased background resulting from smaller telescope aperture, the performance of a CTA system under a steady state background is essentially worse than an equivalent single aperture system. This is in contrast to the ideal case of zero background, discussed previously in Sec. 5, for which the $N=2$ CTA generally performs better than a single telescope receiver with conventional encoding techniques. As discussed in Appendix G in Sec. 11, the performance of a CTA system is comparable to that of a single telescope photon bucket having a FOV that is N times the diffraction limit, irrespective of the background level.

Comparisons of the totally received signal and background counts between an N-element CTA, an equivalent photon bucket, a N-BPSK OCDM system, and single aperture diffraction-limited receiver system, all having the same equivalent photon collection capacities, is summarized in Table 2.

Since the pulsed signal is time gated, the N-DPSK OCDM technique has an intrinsic advantage over other CTA systems under a steady state background. As described later in Appendix I in Sec. 16, the background is effectively reduced by a factor of $\delta t/T \approx 1/N$, where δt is the gating interval. Thus, the N-DPSK OCDM background is comparable to that in a single large aperture telescope system, and is $1/N$ times less than in other N-CTA systems. However, this advantage cancels out if the performance is compared to a single large aperture telescope system using the same N-DPSK OCDM technique.

6.5 Prospectives of a CTA Transceiver

It is important to note that, by virtue of the reciprocity theorem of Helmholtz,[19] a CTA receiver system is also capable of functioning as a transmitter. While an analysis of CTA transmitters is beyond the scope of the present work, one can immediately see that the resulting N-times larger transmitter beam divergence may substantially relieve the hard work of finding a needle in a hay stack to be accomplished by the acquisition, pointing, and tracking (APT) part of the receiver system.

7 Conclusions

A CTA with DPSK self-homodyne interferometric detection performs significantly better than direct detection methods such as BPPM and other conventional coherent techniques. This benefit does not originate from a coherent superposition of the signal photons, but from an incoherent interaction of the background photons, which is unique only to demodulation techniques employing a time delay directly constrained to the data or modulation rate, such as DPSK-SHI and N-BPSK OCDM.

Under ideal or low background conditions $(K_B \ll K_S)$, a CTA with $N=2$ performs better than an equivalent single aperture receiver operating under conventional encoding/decoding techniques. However, this advantage vanishes under high background levels $(K_B \approx K_S)$, primarily because of the increased FOV of smaller telescopes.

In case a diffraction-limited receiver telescope of desired dimension is technically not feasible, the CTA offers the possibility to build an effective very large telescope system from many smaller subtelescopes as an alternative to a conventional photon bucket, while still offering additional advantages in terms of costs and transportability, aside from a potential for using a simple correlation technique to suppress the noise (see Appendix H in Sec. 15). For communication through the atmosphere, a further reduction of subtelescope size may even relieve the need for expensive AO systems at the cost of higher background.

The CTA with DPSK-SHI demodulation is very suitable for implementing a new technique known as N-BPSK/OCDM/WDM, recently developed for fiber optic communications with a demonstrated capability of multiterabit per second data rates. Aside from a reduced steady state background, the potential for such extremely high data rates renders the CTA highly relevant not only for ground-to-satellite and intersatellite communications, but also for future unmanned aircrafts, and as a powerful means in the current endeavor for achieving information dominance in the battlefield.

Since a CTA can also serve as a transmitter, in principle the entire communication system, both transmitter and receiver, can be made of the same standard building blocks. This makes the CTA an excellent candidate for standard equipment for military units, thereby offering low cost, light weight, high performance, and high flexibility, capable of handling widely and rapidly varying conditions such as in a battlefield environment.

8 Appendix A: Notations

8.1 Electromagnetic Waves

The notations regarding electromagnetic waves used throughout this work are made consistent with Ref. 19, specifically Chapters 7.2, 7.3, 7.5, and 8.5. The electric field vector $\mathcal{E}(\mathbf{r},t)$ of an optical wave is represented by

$$\mathcal{E}(\mathbf{r},t) = \mathcal{R}_e[A(\mathbf{r})\exp{-j\omega t}]$$
$$= 1/2[A\exp{-j\omega t} + A^*\exp{-j\omega t}], \quad (20)$$

where $A(\mathbf{r})$ is a complex amplitude in Cartesian coordinates having the components A_x, A_y, and A_z; the asterisk (*) denotes the complex conjugate of the marked quantity; $\mathcal{R}_e$

stands for the real part of a complex quantity within the bracket that follows; and ω is the angular frequency of the light wave. Conventionally, vector quantities are denoted by bold letters. In the following, we only consider complex amplitude vectors of one polarization only, such as what is measured behind a polarization filter. Under this condition, complex wave vectors become phasors (phased amplitudes).

Taking an average value of time varying quantities over time periods much longer than the inverse optical frequency $T \gg 2\pi/\omega$, the light intensity $I(\mathbf{r},t)$ related to the electric field $\mathcal{E}(\mathbf{r},t)$ can be expressed as

$$I(\mathbf{r},t) = |\mathcal{E}(\mathbf{r},t)|^2 = 1/2 \mathbf{A} \cdot \mathbf{A}^*. \tag{21}$$

Under this convention, (polarized) wave vectors $\mathbf{A}$ and $\mathbf{B}$ differing in phase by a relative phase difference Φ are represented by $\mathbf{A}\exp{-j\omega t}$ and $\mathbf{B}\exp{-j(\omega t+\Phi)}$, respectively.

8.2 Light Signal Power, Photon Energy, and Photon Number

The notations used for describing the relationships between signal count statistics, photon energy, and electromagnetic waves are taken from various sources, while being meticulously made consistent with the previous notations adopted from Ref. 19.

The average power $P(t)$ measured over a surface area S is conventionally defined as

$$P(t) = \int^S I(\mathbf{r},t) dS = \int^S |\mathcal{E}(\mathbf{r},t)|^2 dS, \tag{22}$$

and the wave energy measured within a time interval $\Delta\tau$ ($\gg 2\pi/\omega$) is consequently

$$E_b = \alpha \int^{\Delta\tau} P(t) \cdot dt = \alpha \int^{\Delta\tau} 1/2 |A(t)|^2 \cdot dt. \tag{23}$$

To compare the performance of various modulation schemes in terms of BER, it is customary to use the standardized quantity "*photon energy per bit*" E_b, directly related to the number of (signal) photons $K_s = E_b/h\upsilon$, where h is the Planck's constant and $\upsilon = \omega/2\pi$ is the light frequency.

Due to the 50% duty cycle, the photon energy per bit for BPPM is defined by Eq. (23) with $\Delta\tau = T/2$, where T is the signaling interval. On the other hand, most coherent techniques, including the DPSK, have a 100% duty cycle. For such coherent modulations, the time integration in Eq. (23) is performed with $\Delta\tau = T$.

Since the BER is conventionally expressed in terms of photon energy per bit E_b, or photon number $K_s = E_b/h\upsilon$, it is convenient to spare the effort of writing every time the integrations over signaling time T and beam cross section S, and conventionally express a polarized light wave vector $\mathbf{A}$ directly in terms of the photon energy per bit E_b, thereby conferring the phase of the amplitude $\mathbf{A}$ to the corresponding photon energy per bit E_b, so as to form a phasor or phased amplitude of magnitude $\sqrt{E_b}$.[22] Taking $E_S = E_b$ (BPPM) as a standard signal count for comparison, we thus have E_b (DPSK) $= 2 E_b$ (BPPM) $= 2 E_S$.
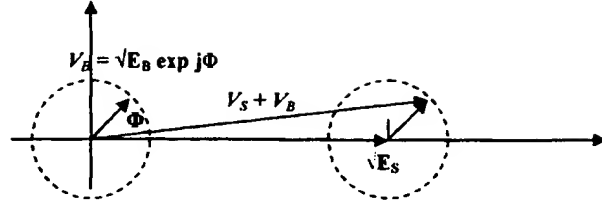
Fig. 7 Phasor diagram of signal and noise.

The sum of a polarized vector $\mathbf{V}_S$ representing a signal of bit energy $\sqrt{E_b} = \sqrt{E_S}$ superimposed onto a background of bit energy $\sqrt{E_b''} = \sqrt{E_B}$ representing a (polarized) noise vector $\mathbf{V}_S$ is shown in Fig. 7. The random phasor of BG photons $\sqrt{E_B}\exp{j\varphi}$ is randomly distributed around the signal phased amplitude $\sqrt{E_S}$, where E_S is the photon energy per signal pulse.

The statistical behavior of a signal vector of amplitude $\sqrt{E_S}$, which is corrupted by an incoherent background noise of energy E_B and random phase Φ, can be analyzed based on Fig. 7, in which the signal and background noise amplitude are defined as $\mathbf{V}_{S,B} = \sqrt{E_{S,B}}$ according to the convention.

Throughout this work, a mean or time average of a statistical quantity $\mathbf{V}(t)$ is defined as

$$\langle\mathbf{V}\rangle \equiv (1/T)\int_0^T \mathbf{V}(t) dt, \quad \text{with} \quad T \gg 2\pi/\omega. \tag{24}$$

The time average of vector $\mathbf{V}_S + \mathbf{V}_B$ is thus

$$\langle\mathbf{V}_S + \mathbf{V}_B\rangle = \langle\mathbf{V}_S\rangle + \langle\mathbf{V}_B\rangle, \tag{25}$$

and the associated energy is

$$\langle|\mathbf{V}_S + \mathbf{V}_B|^2\rangle = \langle(\mathbf{V}_S + \mathbf{V}_B)\cdot(\mathbf{V}_S^* + \mathbf{V}_B^*)\rangle. \tag{26}$$

Equation (26) can be evaluated by inserting the corresponding signal and noise values in the (polarized) vectors $\mathbf{V}_S$ and $\mathbf{V}_B$, which, for equally polarized vectors, then yields

$$\langle|\mathbf{V}_S + \mathbf{V}_B|^2\rangle = \langle\{\sqrt{E_S} + (\sqrt{E_B})\exp{j\Phi}\}$$
$$\cdot\{\sqrt{E_S} + (\sqrt{E_B})\exp{-j\Phi}\}\rangle$$
$$= E_S + E_B + \sqrt{(E_S \cdot E_B)}\cdot 2\langle\cos\Phi\rangle, \tag{27}$$

where the term $\langle\cos\Phi\rangle$ is equal to zero, since Φ is a random phase uncorrelated to the phase of the wave vector $\mathbf{A}_R = \sqrt{(2\cdot E_S)}\exp(0)$. We thus have

$$\langle|\mathbf{V}_S + \mathbf{V}_B|^2\rangle = E_S + E_B. \tag{28}$$

Thus a signal amplitude $\sqrt{E_S}$, superimposed on a white background noise having a zero mean $\sqrt{E_B}$, measured by a square-law detector, results in a scalar addition of the individual signal and BG magnitudes.

8.3 White Noise Representation

Using the results derived in Appendix A in Sec. 8, the noise (assumed to be a white noise having a zero mean) can be represented by a superposition of (polarized) noise vectors or amplitudes $\sqrt{E_B}$, each having a random phase $\varphi_{\omega'}(t)$

$$E_B = \left| \sum_{\omega' = -B/2}^{+B/2} \sqrt{E_B(\omega')} \exp j\varphi_{\omega'}(t) \right|^2, \tag{29}$$

whereby $\omega' = \omega - \omega_0 \ll \omega_0$, $\varphi_{\omega'}(t)$ is a random phase and E_B is the noise energy per bit symbol interval integrated over the filter bandwidth $\Delta\omega' = \Delta\omega = B$, i.e.,

$$\langle E_B \rangle = \int_0^T \alpha P_B(t) dt$$

$$= \int_0^T dt \cdot \left\langle \sum_{\omega' = -B/2}^{+B/2} [\sqrt{\{E_B(\omega')E_B(\omega'')\}} \right.$$

$$\left. \cdot \exp j(\varphi_{\omega'} - \varphi_{\omega''})] \right\rangle$$

$$= \sum_{\omega' = -B/2}^{+B/2} \left[\sqrt{\{E_B(\omega')E_B(\omega'')\}} \right.$$

$$\left. \cdot \left\langle \left| \int_0^T \exp j(\varphi_{\omega'} - \varphi_{\omega''}) dt \right| \right\rangle \right.$$

$$= \sum_{\omega' = -B/2}^{+B/2} \sqrt{\{E_B(\omega')E_B(\omega'')\}} \cdot \delta(\omega' - \omega'')$$

$$= \sum_{\omega' = -B/2}^{+B/2} E_B(\omega') = E_B \to K_B \cdot h\nu, \tag{30}$$

whereby K_B is the background photon count received within a time interval $t = 0 - T$.

Summing up postdetection output signals from two identical receivers $(N = 2)$, we obtain

$$\langle E_{N=2} \rangle = \langle N \cdot E_{S,B} \rangle = 2 \langle E_{S,B} \rangle. \tag{31}$$

Integration of the sum of signal plus background over one bit intervals yields

$$\langle E_{N=2} \rangle = \langle 2E_S + 2E_B \rangle$$

$$= 2\langle E_S \rangle + 2\langle E_B \rangle + 2\langle \sqrt{(E_S E_B)} \cdot \cos \varphi_\omega \rangle$$

$$= 2\langle E_S \rangle + 2\langle E_B \rangle + 2\sqrt{(E_S E_B)} \cdot \langle \cos \varphi_\omega \rangle$$

$$\to h\nu \cdot (2K_s + 2K_B), \tag{32}$$

where $\langle \cos \varphi_\omega \rangle = 0$ due to the random phase of the noise (i.e., no phase correlation between noise and signal waves). This condition may become violated for very narrow filter bandwidths (typically $\Delta\nu_F \geq 2/T \approx 10\,\text{GHz}$, or $\Delta\lambda_{BG} \leq 0.01\,\text{nm}$). In such cases the background noise carrying no information might undesirably increase by an additional nonvanishing term originating from $\langle \cos \varphi_\omega \rangle$.
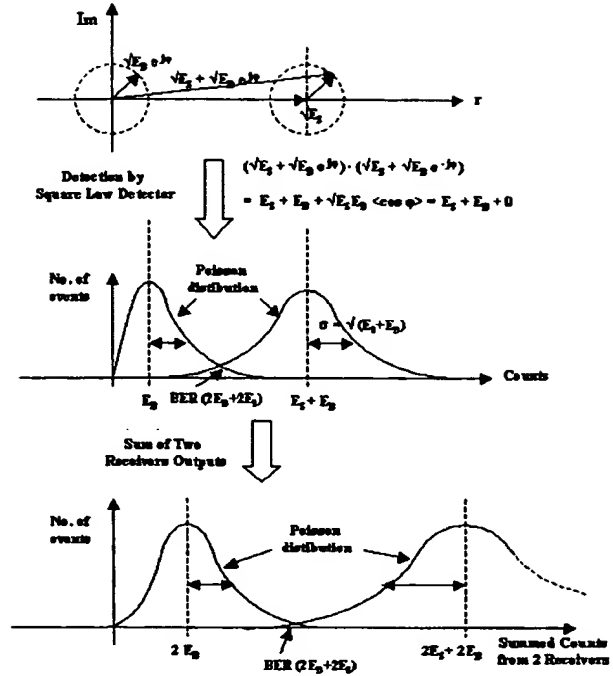
Fig. 8 Poisson distributions of signal and background counts.

9 Appendix B: Direct Detection of Incoherent BPPM Signal

The process of converting an electromagnetic intensity I, or power P, into photon energy E_b that can be directly correlated to photon counts K, is a statistical process in which the quantity E_b as obtained from Eq. (23) becomes the expectation value of the statistical distribution of a measurable quantity K_S.[20,21] Under most circumstances, the statistical distribution of photon count K_S is Poissonian. The probability $P(k)$ of obtaining a photon count k from a distribution having an average count of K is given by the Poisson formula[20,21]

$$P(k, K) = (K^k / k!) \cdot \exp - K. \tag{33}$$

For large values of K, the Poisson distribution may be approximated by a Gaussian distribution with the same mean (expectation) value K and the same variance $\sigma^2 = K^2 + K$

$$G(u, \sigma) = (\sigma \sqrt{2\pi})^{-1} \cdot \exp - (u - K)^2 / 2\sigma^2. \tag{34}$$

Alternative BER formulas under the Gaussian approximation are given in terms of the signal-to-noise ratio (SNR), which in this case takes the form[14,20,21]:

$$\text{SNR} = K_S^2 / (K_S + 2K_B). \tag{35}$$

Gaussian distributions for combined signal and noise count phasors, as given in Eqs. (23) to (28) and Fig. 7, are illustrated in Fig. 8. Gaussian approximations of BER formulas for $K_B = 0$ have been previously used in Eqs. (13) through (17).
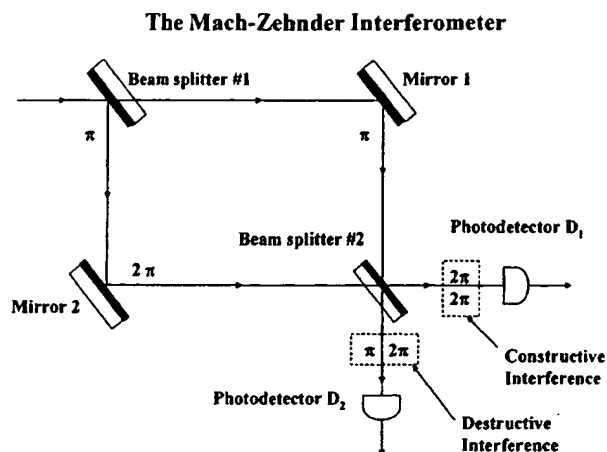
The Mach-Zehnder Interferometer

Fig. 9 The Mach-Zehnder interferometer.

10 Appendix C: Mach-Zehnder Interferometer

The principle of a Mach-Zehnder interferometer is illustrated in Fig. 9. Beamsplitters 1 and 2 are both 50% reflecting and 50% transmitting, thus dividing an incoming photon beam into two equal intensities. A phase change of π is incurred to polarized photons on reflection from dielectric surfaces,[23] such as mirrors 1, 2, and beamsplitter 2 to photons incoming from mirror 1.

No phase change is incurred to photons incoming from mirror 2 on reflection from the backside of beamsplitter 2. Assuming the two interferometer arms are well adjusted (optical path lengths are equal or differ by $2n\pi$), we have on detector D_1 a superposition of two light waves having a phase difference of $0 \pm 2n\pi$, thus resulting in a constructive interference. On the other hand, on detector D_2 the phase difference is $\pi \pm 2n\pi$. Thus, the interference is destructive, i.e., detector D_2 never registers any photon. The situation is reversed if one of the interferometer arms is longer than the other by a multiple of half a wavelength, corresponding to a phase difference of π. Both cases occur in DPSK in an alternating manner representing the baseband signal. [Note that all interference effects remain preserved even to very low photon counts, because every photon is basically interfering with itself. The second order correlation effect (photon antibunching) is not considered here.]

Today, a classical interferometer as described earlier can be substituted by its fiber optic or integrated optics version. For example, a 2×2 fiber optic MZI based on single mode fused couplers having two complementary outputs is described in Ref. 24. Geometrically, a fiber optic MZI provides the best match to a diffraction-limited receiver telescope. Another alternative is a thin-film planar waveguide-based integrated optics MZI, which is also available on the market, e.g., from Ref. 25. A planar waveguide device can be designed to match a fiber optic input.

10.1 DPSK Self-Homodyne MZ Interferometric Demodulation

Reference signal $=(1)$,

Baseband signal $S(t) = (1)\ 1\ 0\ 1\ 1\ 0\ 0\ 0\ 1\ 1\ 0$,

DPSK encoded signal $=(1)\ 1\ 0\ 0\ 0\ 1\ 0\ 1\ 1\ 1\ 0$,

Phase DPSK signal $=(0)\ 0\ \pi\ \pi\ \pi\ 0\ \pi\ 0\ 0\ 0\ \pi$,

Delayed phase DPSK signal

$=0\ 0\ \pi\ \pi\ \pi\ 0\ \pi\ 0\ 0\ 0$,

Phase difference $=0\ \pi\ 0\ 0\ \pi\ \pi\ \pi\ 0\ 0\ \pi$,

Interference pattern in $D_1 = c\ d\ c\ c\ d\ d\ d\ c\ c\ d$,

Recovered baseband signal $=1\ 0\ 1\ 1\ 0\ 0\ 0\ 1\ 1\ 0$.

The DPSK original baseband signal is thus equal to the normalized MZ interferometric signal under constructive interference $\delta = 2n\pi$,

$$S = \cos^2 \delta/2 = \cos^2 \Delta\Phi/2, \tag{36}$$

where $\Delta\Phi = \pi \cdot S(t)$, with $S(t)$ being the original baseband signal.

11 Appendix D: Effects of Beam Divergence in Mach-Zehnder Interferometer

In a conventional mirror-based MZI, a diffraction-limited condition is established by placing appropriately sized pinholes at the focus of the telescope lens or mirror. In fiber optic telescope systems, this pinhole is replaced by the fiber optic core.

For a plane wave entering both subtelescopes into a MZI with intensities I_1 and I_2, respectively, a superposition of two beams of phased amplitudes $\sqrt{I_1}/2$ and $\sqrt{I_2}/2$ under perfect MZI alignment gives rise to two complementary output intensities I_1 and I_2 behind the 50/50% beamsplitter/combiner (for $\Delta\Phi = 0$),

$$I_{1,2} = [\sqrt{(\mathbf{I_1}/2)} + \sqrt{(\mathbf{I_2}/2)}]^2$$

$$= I_1/2 + I_2/2 + 2[\sqrt{(I_1 \cdot I_2)}] \cdot \cos \delta_{1,2} \tag{37}$$

with $\delta_1 = 2\pi \cdot \Delta x/\lambda$, $\delta_2 = \delta_1 + \pi$ (due to reflection by the beamsplitter, see Appendix C in Sec. 10), λ is the wavelength, and Δx is the optical path difference between the two beams traveling along two different interferometer arms. Bold letters in Eq. (37) denote phased amplitudes.

If the input intensities are equal, i.e., $I_1 = I_2 = I_0$, Eq. (37) can be expressed as a quadrature of complementary signals

$$I_1 = 2 \cdot I_0 \cdot \cos^2 \delta_1/2, \tag{38}$$

$$I_2 = 2 \cdot I_0 \cdot \sin^2 \delta_1/2. \tag{39}$$

For a constructive interference $\delta_1 = 2n\pi$, such that $I_1 = 2 \cdot I_0$, whereas the complementary output, I_2, is zero. Irrespective of the quadrature angle δ_1, the total output intensity is always equal to the total input intensity, which agrees with the conservation law of energy and/or photon number.

This condition does not change, even if the beams propagating along the two interferometer arms are (equally) divergent, as long as the interferometer mirrors are perfectly aligned, so their respective concentric wavefronts perfectly coincide. Thus, the constructive interference, as seen on a screen placed behind the output I_1, shows no interference fringe, but only a uniformly illuminated spot, either bright or dark.[19] If there is a varying intensity measured over a bright spot, this does not originate from the $\cos^2 \delta_1/2$ term due the phase term δ in Eqs. (38) and (39), as in Young's double slit experiment, but from the natural intensity distribution of a Gaussian beam.

Interference fringes appear only if the MZI mirrors are misaligned (Bate's modification[19]). Therefore, inasmuch as the MZI mirrors are perfectly aligned, the phase term δ_1 is always zero (or constant) over the cross section of the output beam. In case of a mirror misalignment, a partial fringe, or a number of fully developed interference fringes appearing on the screen, the phase term δ_1 is spread between $\delta_1 = \pm \pi$, and a measurement over the entire spot will then result in $\langle \cos^2 \delta_1/2 \rangle = 1/2$, and hence, $I_1 = I_0$. However, the complementary output also gives the same result, i.e., $I_2 = I_0$ (only with the fringe phases inverted), such that the conservation law for energy and photon number remains fulfilled.

As a matter of fact, beam divergence due to self-diffraction has no impact on the interference (of two or more of such beams), but is an inherent condition that has lead to the cross sectional confinement of the beam itself, in this case a Gaussian beam.

11.1 Diffraction Limit Condition

Although less obvious, the same situation prevails in the focusing of a divergent beam onto a diffraction-limited spot, which is known to have an angular distribution given by the Airy function[19]

$$Ay(\theta) = A_0 \cdot [J_1(k \cdot a \cdot \sin \theta)/k \cdot a \cdot \sin \theta]^2, \qquad (40)$$

$$\approx A_0 \cdot [J_1(k \cdot a \cdot \theta)/k \cdot a \cdot \theta]^2, \qquad (41)$$

where A_0 is a normalization constant, $J_1(x)$ is the first order Bessel function of the first kind, $a = D/2$ is the radius of the aperture, θ the divergence angle, $k = 2\pi/\lambda$ is the propagation number, and λ is the light wavelength.

The finite divergence of a Gaussian beam focused by a lens is not to be conventionally convoluted with the Airy function to obtain the total light intensity imposed on a fiber optic core entrance surface. The correct interpretation is that the external light wave excites one of the fiber's own propagating modes, the efficiency of which is given by the degree of coupling ρ between the two waves, the latter determined by the overlap integral between the electric fields of the external and internal waves.[9]

In terms of geometrical optics, the coupling efficiency can be estimated from the fractional part of the incoming power passing through the aperture of a lens (or mirror), which is admitted by the acceptance angle of a fiber. This fraction $A(x_i)$ is given by the integral of the Airy function, Eq. (41), over the fiber core aperture, i.e.,

$$A(x_i) = A_0 \cdot \int_0^{x_i} [J_1(x)/x]^2 dx, \qquad (42)$$

where $x = k \cdot a \cdot \sin \theta \approx k \cdot a \cdot \theta$, A_0 is a normalization constant obtained by evaluating the integral form $\theta = 0$ to $\theta = \infty$, and x_i is conventionally taken as being one of the zero points of the Airy function, which occurs at $x_1 = 3.833$, $x_2 = 5.136$, $x_3 = 7.016$, etc., corresponding to the diffraction limit half angles $\theta_1 = 1.22 \cdot \lambda/D$, $\theta_2 = 1.635 \cdot \lambda/D$, $\theta_3 = 2.23 \cdot \lambda/D$, etc. Executing the integral in Eq. (42), the fraction of the incoming power falling within the first, second, and third Airy disk is 83.8, 91.0, and 93.8%, respectively.

In order for this admitted fraction of incoming light power to be propagated along the fiber core, two independent criteria have to be satisfied. First, the numerical aperture (NA) of the projecting system (lens/mirror) must match the NA of the fiber, which is typically about 0.25 for single mode fibers. Thus, the projection system must have a NA of ≤ 0.25, which roughly corresponds to an f number of $f_N < 4$. This condition is technically very feasible for small to moderate size lenses or mirrors. The second condition is the divergence angle, as determined by the fiber core diameter [or alternatively, the mode field diameter (MFD)], and the focal length of the lens/mirror must match the diffraction-limited angle of the projection system. Single mode fibers are available with fiber core diameters (or MFDs) between 4 to 16 μm, typically $d_f = 8$ μm. The diffraction limit condition is $d_f/2f \approx 1.22 \cdot \lambda/D$, or $1.635 \cdot \lambda/D$, for accepting 83.8 or 91% of the total incoming power that has passed through the lens/mirror aperture. Hence, in the first case the diffraction limit condition yields $f_N = f/D = 8$ μm/2.44 $\cdot \lambda \approx 3.3$ for a wavelength of typically 1 μm, whereas in the second case, $f_N = 8$ μm/3.27 $\cdot \lambda \approx 2.4$. Both values are technically feasible for small to moderate lens/mirror sizes, but become increasingly difficult for large lens or mirror diameters. Due to the wide range of possible choices in fiber core or MF diameters, lens/mirror diameters and focal lengths, and the fractional power desired, the transmission/insertion loss is left unspecified in the BER calculations performed in this work.

12 Appendix E: Method for Combining the BERs of N Subtelescopes

The BER for N identical subreceivers can be derived by a simple method, given that the probability of error (PE) for one receiver output is already known. Provided that each receiver gives a statistically independent output (which is not necessarily true for single photon cases), the combined probability of error for two receivers is a sum of the probability that both receivers show erroneous results, i.e., PE^2, plus the probability that one receiver is wrong (=PE) but the other is correct (=1-PE), i.e., PE·(1-PE). This is because the combined probability of two statistically independent processes is simply a multiplication of the individual probabilities.

However, in the latter case it is impossible to correctly decide which one of the two receivers is correct, and which one is wrong. With the probability for either case being equal, the two equivalent PE(1-PE) terms must be weighted by 1/2 before adding to the end result. Therefore, the com-

bined probability of error for $N=2$ is the sum of the probability that both receivers A and B are wrong, plus 1/2 times the probability that receiver A is wrong but receiver B is correct, plus 1/2 times the probability that receiver B is wrong but receiver A is correct, i.e., $PE^2 + 1/2 \cdot PE(1-PE) + 1/2 \cdot PE(1-PE) = PE$. Thus, information provided by a second receiver B does not improve the overall error probability at all! This is not surprising, since the additional information provided by a second receiver, which makes an even number of receivers, does not provide any useful help to determine the correctness of the signal received due to the ambiguity or undecisiveness previously discussed. This indecisiveness, and hence the fact that the overall error probability (i.e., the BER) does not further improve, occurs every time the number of telescopes is even, as will be made obvious in the next section. This behavior reflects the same condition prevailing in the previous direct detection case, in which the BER is calculated according to an OOK scheme for $N=1$ (odd) and to a BPPM scheme for $N=2$ (even), the latter being smaller than the former.

For $N=3$, the BER is a sum of the combined PE ($=$CPE) that all three receivers are wrong, i.e., PE^3, plus the cPE that two receivers are wrong and only one is correct, i.e., $PE^2 \cdot (1-PE)$, of which there are in total 3 cases ($=$combination of 2 from 3, i.e., $C(3,2) \equiv (3!)/[2! \cdot (3-2)!] = 3$). The case of two receivers being correct and one wrong does not contribute to the total CPE if one chooses to take the result given by the majority of the N telescopes. In the cases where N is odd, it is always possible to make a fully unambiguous decision. Therefore, for $N=3$ we have a BER of $PE^3 + 3 \cdot PE^2 \cdot (1-PE) = 3 \cdot PE^2 - 2 \cdot PE^3$.

For $N=4$ the BER is a sum of CPEs that all four receivers are wrong ($=PE^4$), three are wrong and one is correct $[=PE^3 \cdot (1-PE)]$, of which there are $C(4,3)=4$ cases, and two being wrong and/or correct $[=PE^2 \cdot (1-PE)^2]$, of which there are in total $C(4,2)=6$ cases, but they must be weighted by 1/2 each, due to the same ambiguity/indecisiveness discussed previously. The combined BER for $N=4$ is therefore $PE^4 + 4 \cdot PE^3 \cdot (1-PE) + (6/2) \cdot PE^2 \cdot (1-PE)^2 = 3 \cdot PE^2 - 2 \cdot PE^3$, which is exactly the same as what has been obtained for $N=3$.

The procedure can be set forth for arbitrary large numbers of telescopes/receivers. The combined BER for N telescopes/receivers expressed in terms of the (bit) error probability for a single telescope/receiver ($=$PE) is tabulated in Table 1.

13 Appendix F: Effect of Transmitter Beam Divergence

The power P_{rec} received at the receiver's entrance pupil can be expressed as[26]

$$P_{rec} = P_L \frac{\pi^2 D_{tr}^2}{\lambda^2} \frac{\lambda^2}{4^2 \pi^2 R^2} \frac{\pi^2 D_{rec}^2}{\lambda^2} (G/L), \qquad (43)$$

where P_L is the (laser) transmitter power, D_{tr} and D_{rec} are the diameter of the transmitter and the receiver telescope apertures, respectively, λ is the optical wavelength, R is the
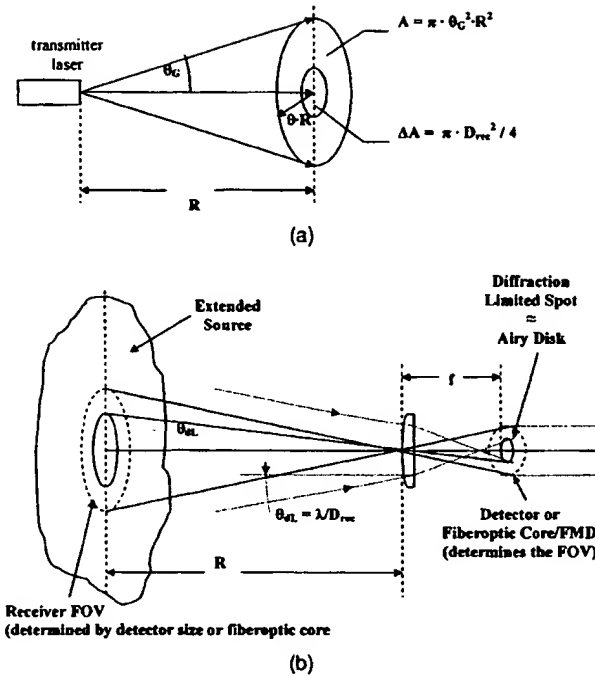

Fig. 10 (a) Transmitter beam divergence and (b) spatial modes of background photons.

communication link distance, and G or L is the net gain or loss incurred by the optical systems, e.g., due to absorption in the optical materials.

Equation (43) can be modified into

$$P_{rec} = P_L (\pi/4)^2 \cdot [(D_{tr} D_{rec})/(\lambda \cdot R)]^2 G/L. \qquad (44)$$

Equation (44) has the interpretation of a transmitter signal beam having a Gaussian divergence angle $\theta_G = \lambda/(\pi \cdot w_0) = 2\lambda/(\pi \cdot D_{tr})$, projected over a link distance R into a circle of radius $R \cdot \theta_G$ and area $A = \pi \cdot R^2 \cdot \theta_G^2 = 4R^2\lambda^2/(\pi D_{tr}^2)$, which is normally (much) larger than the receiver aperture area, $\Delta A = \pi \cdot D_{rec}^2/4$. As depicted in Fig. 10(a), the receiver receives only a fraction $\Delta A/A$ of the transmitter power P_L, i.e.,

$$P_{rec} = P_L \Delta A/A \, G/L = P_L (\pi \cdot D_{rec}^2/4)/(4R^2\lambda^2/(\pi D_{tr}^2) G/L,$$

which finally yields the same expression as in Eq. (44),

$$P_{rec} = P_L \times G/L \times (\pi/4)^2 \cdot [(D_{tr} \cdot D_{rec})/(\lambda \cdot R)]^2. \qquad (45)$$

In case the transmitter beam does not have a TEM_{00} Gaussian mode, Eq. (45) is to be modified by correcting/increasing the divergence angle by a "laser times diffraction limit" factor M^2.[27]

13.1 Spatial Modes of Background Photons

For an extended source (e.g., planetary disk) observed by a nondiffraction-limited receiver with a FOV larger than $\Omega_{dL} = \pi \cdot \theta_{dL}^2$, e.g., using a detector of radius $r_D > f \cdot \theta_{dL}$ as illustrated in Fig. 10(b), the received portion of total BG radiation into the hemisphere emitted by the extended BG
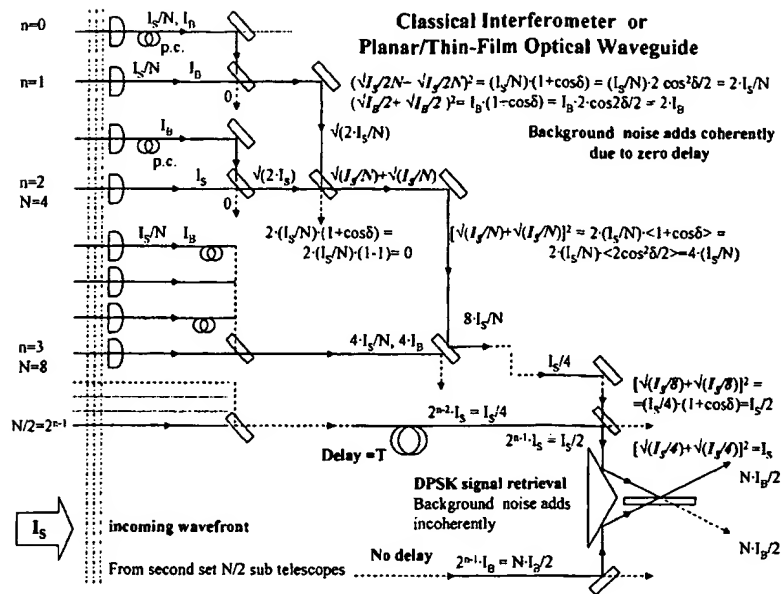
Classical Interferometer or
Planar/Thin-Film Optical Waveguide

n=0 $I_s/N, I_B$
   p.c.

n=1 I_s/N I_B
   0

$(\sqrt{I_s/2N} - \sqrt{I_s/2N})^2 = (I_s/N)(1+\cos\delta) = (I_s/N)\cdot 2\cos^2\delta/2 = 2\cdot I_s/N$
$(\sqrt{I_s/2} + \sqrt{I_s/2})^2 = I_B\cdot(1-\cos\delta) = I_B\cdot 2\cos 2\delta/2 = 2\cdot I_B$

$\sqrt{(2\cdot I_s/N)}$

Background noise adds coherently
due to zero delay

I_B
   p.c.

n=2
N=4 I_s $\sqrt{(2\cdot I_s)}$ $\sqrt{(I_s/N)} + \sqrt{(I_s/N)}$
   0

$2\cdot(I_s/N)\cdot(1+\cos\delta) =$ $[\sqrt{(I_s/N)} + \sqrt{(I_s/N)}]^2 = 2\cdot(I_s/N)\cdot<1+\cos\delta> =$
$2\cdot(I_s/N)\cdot(1-1) = 0$ $2\cdot(I_s/N)\cdot<2\cos^2\delta/2> = 4\cdot(I_s/N)$

I_s/N I_B

$8\cdot I_s/N$

n=3
N=8 $4\cdot I_s/N, 4\cdot I_B$

$I_s/4$

$[\sqrt{(I_s/8)} + \sqrt{(I_s/8)}]^2 =$
$=(I_s/4)\cdot(1+\cos\delta) = I_s/2$

N/2=2^{n-1}

$2^{n-1}\cdot I_s = I_s/4$

$2^{n-1}\cdot I_s = I_s/2$

$[\sqrt{(I_s/4)} + \sqrt{(I_s/4)}]^2 = I_s$

Delay = T

DPSK signal retrieval
Background noise adds
incoherently

$N\cdot I_B/2$

I_s
incoming wavefront

No delay $2^{n-1}\cdot I_B = N\cdot I_B/2$ $N\cdot I_B/2$

From second set N/2 sub telescopes

Fig. 11 Coherence combination of N/2-CTA with SHI demodulation.

source is determined by the receiver's FOV. The ratio of the receiver's FOV and the diffraction-limited angle θ_{dL} is defined as the number of spatial modes D_S under the assumption of an extended source, for which the solid angle subtended by the source $(D_{tr}/R)^2$ is much larger than the receiver's FOV.[20] A diffraction-limited receiver is thus defined as a receiver system operating at a single spatial mode.

Wherease the number of spatial modes for background photons is usually (much) larger than one, the signal photons are focused to only one single spatial mode at the receiver's diffraction-limited focal spot. This is easily demonstrated by taking the radius of the geometrical image of the transmitter aperture at the focus, i.e., $a_F = \pi \cdot (D_{tr}/2)^2 \cdot f^2/R^2$, and comparing this with the diffraction-limited focus area of a Gaussian beam, $\delta a = \pi \cdot (f \cdot 2\lambda/\pi \cdot (D_{rec}/2)^2 = 4\lambda^2 f^2/(\pi \cdot D_{rec}^2)$ to obtain:

$$\delta a/a_F = (4/\pi)^2 \cdot [\lambda^2 R^2/(D_{tr}^2 D_{rec}^2)]. \quad (46)$$

This ratio is exactly the same as the inverse ratio $A/\Delta A$ from Eq. (45), and hence is always greater than unity. However, this would mean that the geometrical image of the transmitter aperture a_F is smaller than the diffraction spot of a Gaussian beam, which is obviously an impossible situation. The correct interpretation is that a transmitter beam is always focused into a diffraction spot, i.e., into a single spatial mode. If the geometrical image a_F of the transmitter aperture D_{tr} on the receiver's focal plane is so increased that Eq. (45) is reduced to unity, it means that the transmitter's beam diameter is now reduced to just filling up the receiver aperture. A further increase of the transmitter, or the receiver aperture, would not increase the number of signal photons received, since the entire transmitter power has been already admitted.

As noted previously, an increase of the receiver's FOV, e.g., by using a larger detector pixel or a larger fiber core or

field mode diameter (FMD), will not increase the number of signal photons, since the entire transmitter power is focused into a diffraction-limited spot δa. However, increasing the detector pixel size or the fiber core diameter beyond the diffraction limit would increase the background photons. This is because the receiver FOV is increased, and so is also the number of spatial modes admitted by the detection system. Therefore, reducing the subtelescope size in a CTA will not enhance the total number of signal photons, but only increase the background.

The reduction of signal photons received by each of the smaller subtelescopes follows from Eq. (44) or Eq. (45), whereas the increase of the background is due to the increased number of spatial modes, as illustrated in Fig. 10(b). It is then obvious that a photon bucket having the same FOV as a CTA subtelescope will receive the same total number of signal photons and the same number of background photons as the CTA system.

14 Appendix G: Comparison of N-CTA/SHI to Single Aperture System

For comparing the performance of an N-CTA/SHI system with a single aperture system of the same total aperture, the number of signal photons received by each subtelescope is reduced by a factor of N, i.e., I_S/N. However, due to larger FOV, the number of background photons received by each subtelescope remains the same as that received by the large aperture, i.e., I_B. Under such a condition, a procedure for coherent summation of signal waves of amplitude $\sqrt{(I_S/N)}$ and an incoherent addition of the background intensity I_B is depicted in Fig. 11. To simplify the procedure, a 7 to 11% excess loss incurred in each 2×1 fiber coupling is ignored.

For illustration purposes, some of the intermediate results along the cascade of interferometric summations are also shown. The final result shows that the DPSK signal scales as I_S and the background as $N \cdot I_B/2$, the latter being equally shared by the complementary outputs of the MZI

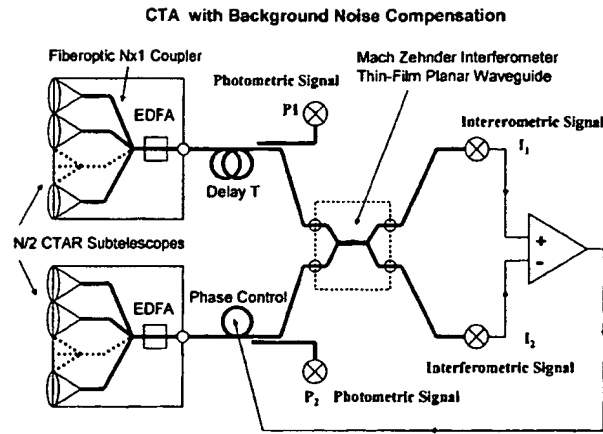**CTA with Background Noise Compensation**

Fig. 12 A novel background noise compensation for CTA receivers.

interferometer. In every stage of the cascade, and in the final result as well, the signal and background inputs are essentially equal to the signal and background outputs, respectively. This photon number or energy conservation principle can be generalized to the N-BPSK/OCDM technique discussed later in Appendix I in Sec. 16. The results for both N-DPSK/SHI and N-BPSK/OCDM are included in Table 2.

15 Appendix H: Novel Technique for Noise Compensation in CTAs

Some commercial MZIs are already equipped with signal monitors for measuring a fraction of the signal arriving at each input port before it enters the MZI. These extra monitors may be used for a simple noise suppression technique that eliminates background noise and phase fluctatiuons not commonly shared by the interferometer arms.

As depicted in Fig. 12, part of the signal received by the subtelescope pair is tapped by a pair of couplers to generate the monitor signals P_1 and P_2. These photometric signals P_1 and P_2 are directly related to the interferometric signals I_1 and I_2 by a matrix equation[9]:

$$I_1 = \kappa_{11}P_1 + \kappa_{12}P_2,$$
$$I_2 = \kappa_{21}P_1 + \kappa_{22}P_2,$$

(47)

where the interferometer transfer matrix coefficients κ_{ij} can be evaluated directly from the data without a priori knowledge of the individual transmissions and gains in the system.[9]

By virtue of Eqs. (48) and (49) we may derive the interferometric signal I_1 from

$$I_1 = \kappa_{11}P_1 + \kappa_{11}P_2 + 2 \cdot \gamma(T) \cdot \sqrt{(\kappa_{11}\kappa_{12}P_1P_2)} \cdot \cos \Delta\Phi,$$

(48)

with $\gamma(T)$ a degree of coherence for a delay time T,[9,28] hereafter assumed to be $\gamma(T) \approx 1$ owing to the long coherence time of lasers used as transmitters.

In case of constructive interference ($\delta = 2n\pi$), Eq. (48) can be rearranged to yield

$$\cos \Delta\Phi = (I_1 - \kappa_{11}P_1 - \kappa_{12}P_2)/2\sqrt{(\kappa_{11}\kappa_{12}P_1P_2)}.$$

(49)

As discussed in Appendix D in Sec. II, the interferometric signal $I_1 = (1 + \cos \Delta\Phi)$, with $\Delta\Phi$ being the same as δ defined in Eq. (37), is the reconstructed baseband signal that would have been obtained if there had been no atmospheric turbulence and other noises, i.e., if P_1 and P_2 had been equal and constant.[9] A case $P_1 = P_2$ may be established when the subtelescopes are looking through the same atmospheric disturbances, which vary at much lower frequencies than the data rate (≤ 1 to 10 kHz$\ll 10$ GHz). In such a case a simple background correction may be conventionally conducted by maximizing the difference between the two complementary outputs, e.g., using a balanced receiver.

However, in most cases a significant part of the noise affects P_1 and P_2 differently. These include, e.g., noise due to EDFA fluorescence, scintillation in the upper atmosphere, detector dark current, and amplifier noise. In this case we have $P_1 = \tilde{U}_1 \neq P_2 = \tilde{U}2$. Consequently, Eq. (49) rigorously has to be written as

$$\cos(\Delta\Phi + \epsilon) = (\tilde{I}_1 - \kappa_{11}\tilde{U}_1 - \kappa_{12}\tilde{U}_2)/2\sqrt{(\kappa_{11}\kappa_{12}\tilde{U}_1 \cdot \tilde{U}_1)},$$

(50)

where ϵ is a small phase fluctuation caused by the noise, and the tildes denote timely varying quantities. Since $\Delta\Phi$ corresponds to the baseband signal $S(t)$ that takes the value of either 0 or π, in the first order of approximation we may write Eq. (50) as

$$(\tilde{I}_1 - \kappa_{11}\tilde{U}_1 - \kappa_{12}\tilde{U}_2)/2\sqrt{(\kappa_{11}\kappa_{12}\tilde{U}_1\tilde{U}_1)}$$
$$= \cos(\Delta\Phi + \epsilon) = \cos \Delta\Phi \cdot (1 - \epsilon^2/2 + \ldots) \approx \cos \Delta\Phi.$$

(51)

Thus, $I_{corr} = 1 + \cos \Delta\Phi$ is the corrected signal, with $\cos \Delta\Phi$ evaluated according to Eq. (50) from the measured timely varying quantities $\tilde{I}_1$, $\tilde{U}_1$, and $\tilde{U}_2$.

Although the basic idea is the same as a technique already established in stellar interferometry,[9] a major difference exists in that the interferometric signal $(1 + \cos \Delta\Phi)$ is a high frequency signal ($\approx 1/T$), since it represents the baseband signal $S(t)$, whereas atmospheric turbulence and other background noise are generally of relatively much lower frequencies (≤ 1 to 10 kHz). In stellar interferometry, the interferometric signal $(1 + \cos \Delta\Phi)$ is a slowly varying function depending on the scan speed of the optical path length difference δ over the zero point. In contrast, the phase due to path length difference $\delta = 2n\pi$ is held constant all the time, which is established by maintaining a maximum contrast between the two complementary interferometer signals. A further study is certainly required before this technique can be established.

16 Appendix I: CTA Implementation of 4-BPSK/OCDM/WDM Technique

Due to close similarities in time-delay and phase-shifting operations, the DPSK-SHI technique is well adaptable to implement a novel technique developed for fiber optic communications, i.e., the N-BPSK/OCDM/WDM technique,
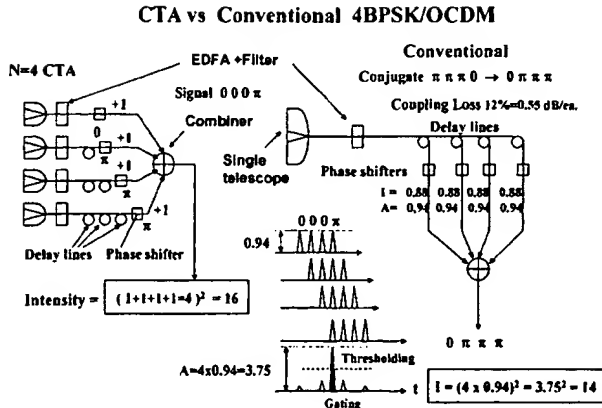
CTA vs Conventional 4BPSK/OCDM

Fig. 13 CTA versus conventional 4 BPSK/OCDM.

which has been recently demonstrated as having the capability of multiterabit per second data rates.[10-12]

A signal receiving schematics is shown in Fig. 13, wherein the original fiber optic version of a 4-BPSK/OCDM/WDM is illustrated on the right-hand side, whereas the CRTA version is illustrated on the left. The WDM part of the technique is not addressed here, since it is irrelevant for understanding the basic concept.

Implementing the CTA concept, N-BPSK/OCDM decoding can be accomplished by using N subtelescopes, where the number of subtelescopes N equals the number of laser pulses in one bit. For comparison with a single aperture system, the signal intensity received by each subtelescope is reduced by the small aperture to I_S/N. We also have N channels, or subtelescopes, each consisting of N ultra-short signal pulses. Thus, we have $N \times N$ pulses to delay and combine. Assuming the residual interferences are all zero except the central pulse, the coherent intensity peak at the center is $N \times I_S/N = I_S$. This can be readily deduced from the principle of conservation of energy or photon number alone, as discussed previously, without going into the details of the coherent superposition in an $N \times 1$ fiber coupler.

As in previous cases, the background count received by each of the N subtelescopes remains to be I_B, owing to the $1/N$ times smaller FOVs. The combined BG intensity at the central peak position of the signal pulse is an incoherent superposition of N background intensities, each having an intensity of I_B. We thus have a signal pulse of intensity I_S sitting on a (stationary) background level of $N \cdot I_B$ that has to be further minimized by time gating, $\delta t \approx T/N$. As shown in Table 2, the performance of this technique is expected to be better than both a photon bucket and N-telescope CTA in terms of photon efficiency. Its potential for multiterabit per second data rate makes the N-BPSK/OCDM technique even more interesting.

17 Appendix J: CTA with Differential Frequency Shift Keying Technique

The same time-delay technique as previously used in DPSK can also be applied to DFSK modulation, but without interferometry, making use of the nonlinear property of an op-

tical square-law detector to generate optical frequency mixing and retrieve the frequency-shifted signal modulation, just like in classical heterodyne/homodyne.

Since recently, state-of-the-art electro-optic devices based on periodically poled lithium niobate (PPLN) waveguides are available in the market for difference frequency mixing. The principle is not different from classical heterodyne detection using square-law detectors, which is assumed as a basis for the BER analysis conducted in Ref. 1.

The BER formula derived in Ref. 1 for DFSK demodulation using a correlation-type rf decoding[22] is:

$$\mathrm{BER} = (2\pi)^{-1/2} \cdot \int_{\surd(E_{SH}/2N_0)}^{\infty} \exp - x^2/2 dx$$

$$= Q[\surd(E_{SH}/2N_0)], \tag{52}$$

with $E_{SH} = 4(E_S \pm \surd E_S E_B')$, and $N_0 = 2\sigma_N^2 = 4\surd E_S E_B'$, where E_S and E_B can be simply replaced by K_S and K_B, respectively. The two possible values of the rf self-homodyne signal, which is a result of a phase shift applied to the signals prior to optical detection, are discussed in Ref. 1 (available on request).

Under the square-law rf decoding technique, both the rf signal and background rates can only have positive values. The rf decoded output referring to the signal is then (from Ref. 1):

$$\mathrm{SQ2} = 8|A|^2 \cdot (E_S^2 + E_S E_B') \pm 16|A|^2 \cdot E_S \surd(E_S E_B'), \tag{53}$$

whereas the rf decoded output referring to the background noise is given by

$$\mathrm{SQN} = 8|A|^2 (E_S \cdot E_B'). \tag{54}$$

As in the previous case of single detector DPSK (Sec. 4.3.1), a threshold k_T must be used to distinguish between signal and noise due to the lack of *a priori* knowledge of the signal strength received.

For both types of rf decoding techniques, the BER depends on the ratio of rf filter bandwidth to optical filter bandwidth B_{rf}/B_0, expressed as $E_B' = E_B' \cdot B_{rf}/B_0$, as is already well known from the conventional heterodyne and/or homodyne techniques.[19-21] As expected, the square-law decoded rf signal output—and hence the BER—depends sensitively on the rf amplifier gain being used, which is incorporated into the wave amplitude A in Eqs. (53) and (54).

Acknowledgments

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summary of ethics rules

u.s. patent and trademark office

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In addition, if you are <u>not</u> a career member of the Senior Executive Service (SES), an administrative law judge, or a contract appeals board member, you may also:
"   serve as an officer of a political party organization; and
"   actively campaign on behalf of a candidate in a *partisan* election, such as by:
    "   soliciting votes by telephone,
    "   stuffing envelopes with campaign literature,
    "   serving as a poll watcher for a party,
    "   writing speeches for candidates, or
    "   otherwise actively managing or assisting a campaign (subject to the limitations listed below).

Limitations. You <u>may not</u>:
"   accept or receive political contributions;
"   solicit political contributions or host political fund-raisers;
"   run as a candidate in a partisan election (except as an independent candidate in certain designated areas, including most of the suburbs of Washington, D.C., but not Washington, D.C. itself); or
"   solicit or accept volunteer services from a subordinate.

MISUSE OF GOVERNMENT
POSITION AND RESOURCES

Use of Government Resources. You may use Government resources only for authorized Government activities. This includes Government equipment, supplies, and services, and the time of Government personnel. You <u>may not</u> use information you receive in the course of Federal service for personal activities, unless the information is also available to the public.

Use of Government Position. You <u>may not</u> use your Government authority, including business contacts obtained through Government employment, for personal activities. In addition, you <u>may not</u> use your Government title in connection with a non-Government activity.

SEEKING EMPLOYMENT AND
POST EMPLOYMENT RESTRICTIONS

Seeking Employment. Once you begin to seek non-Federal employment, you must disqualify yourself from working on any matter as a Government employee in which your prospective employer has a financial interest. Your disqualification must continue until negotiations end through a clear statement by either party or until two months have passed after you have submitted an unsolicited employment proposal (such as a resume) with no response from the prospective employer. Additionally, if you are participating in a procurement over $100,000, you must notify your supervisor and the Ethics Division of employment contacts to a competing contractor.

Post Employment Restrictions. After you leave Federal service, you <u>may not</u>:
" lobby any Federal agency or Federal court (i.e., contact a Federal agency or court on behalf of another to influence Government action) on specific-party matters on which you worked;
" for two years, lobby any Federal agency or Federal court on specific-party matters on which your subordinates worked during your last year of Federal service;
" for one year, lobby any official of USPTO, if you served as a *career* senior employee (pay equivalent to SES level 5 or higher);
" for five years, lobby any official of USPTO, if you served as a *non-career* senior employee (pay equivalent to SES level 5 or higher) (or lobby any Commerce official, if you served as a Presidential Appointee);
" serve as a foreign agent of a foreign government or foreign political party, if you served as a *non-career* senior official;
" for one year, advise or represent foreign governments and foreign political parties, if you served as a senior employee;
" disclose or use certain nonpublic information gained during the course of Federal employment, including information obtained during a trade or treaty negotiation, personal private information, trade secrets or business proprietary information, and national security information; or
" for one year, accept compensation from the winning contractor of a major procurement (over $10,000,000), if you served as a procurement official.

Exceptions **and Special Post Employment Rules.** There are exceptions to some post employment rules regarding testimony under oath, and representing state and local governments, international organizations, educational institutions, health facilities, and environmental research organizations. There are also special rules applicable to attorneys, and to former employees who received buyouts. Contact the Ethics Division for a more detailed summary of these rules.

FINANCIAL DISCLOSURE

Guidelines for Filing a Financial Disclosure Report. If you serve in a position in which you may work on matters which are likely to have a substantial impact on the financial interests of members of the public, you may be designated as being required to file a financial disclosure report. Such reports are due when appointed to such a position and annually thereafter. The information requested on such forms financial investments, liabilities, gifts, non-Federal positions, and arrangements with past and future employers is information relevant to the ethics rules discussed in this handout. Ethics officials review the reports in order to identify potential conflicts of interest and to advise you on means to resolve any problem. For this system to work effectively, you must file your report in a timely manner and you must list all information requested as completely and clearly as possible.

Specific Guidance. When filling out your report, please:
" sign and date the report;
" if reporting a mutual fund, identify the specific fund by name;
" if reporting an IRA or 401(k) plan, identify the specific holdings in the account
" do not list as a gift payments for Government travel these are gifts to the Government and should be reported on a Form CD 210;
" do not list a mortgage on a personal residence, unless you receive income from the property; and
" if listing an investment or position with a closely-held company or a partnership, identify the nature of the business of the company or partnership.

Remember that this information is used to provide advice to you, so the information you include on your report must be specific and complete in order to be useful.

For further advice on ethics rules or their application to specific situations, please call the ETHICS DIVISION at (202) 482-5384.

ETHICS GUIDANCE FOR EMPLOYEES
OF THE
PATENT AND TRADEMARK OFFICE

Financial Conflicts of Interest

<u>Interests in Patents</u>   By statute, USPTO employees are barred from applying for or acquiring a patent or any right or interest in a patent issued by USPTO. This may also preclude you from serving as the member of the board of an organization that holds interests in a patent.

<u>Conflicts of Interests regarding Patent Examiners</u>   If you are a patent examiner, you may not participate in the review of any patent if you have a financial interest in a company that may be affected by the issuance or denial of the patent (unless your interest is in publicly-traded stock valued at $5,000 or less in all affected companies). Because a patent is the grant of exclusive rights to a particular person or company with regard to a device, process, or design, a conflict would be present not only if you hold stock in the patent applicant, but if you hold stock in a company that manufactures similar devices (or markets similar processes or similar designs).

<u>Conflicts of Interest regarding Trademark Examiners</u>   If you are a trademark examiner, you may not participate in the review of any mark if you have a financial interest in the registration applicant regarding that mark (unless the interest is in publicly-traded stock valued at $5,000 or less). A trademark applicant, unlike a patent applicant, is presumed to have a direct interest only in its mark and not in the mark of competitors or others.

<u>Use of Inside Information for Personal Investments</u>   As a USPTO employee, you may have access to nonpublic information; it is important that you do not use any such information when making investment decisions and that you do not disclose such information to others.

Appearances of Bias (Non-Financial Conflicts of Interest)

<u>Participation in Professional Organizations</u>   If you are an active member of a professional organization, such as a member of a association of attorneys or patent professionals, you will be barred from participating in USPTO on matters in which that organization is a party or is representing a party. If this will interfere with your USPTO duties, you should refrain from such activities or should seek advice from the Ethics Division. If you are serving with an organization, you must be careful not to co-mingle your private and Government activities, such as by speaking at an

organization event in your official capacity or while on Government time. If it is useful for your office to provide input to the organization, you may be permitted to serve as a liaison in an official capacity, but only if you do not also have a role with the organization in a private capacity. You may not serve in an official capacity as an officer or director of a non-Federal organization (unless it is a standards-setting body).

Authorization to Participate in a Matter Involving a Former Employer or Client A s noted in the summary of ethics rules, you generally may not participate in a matter if one of the parties is a former employer or client, or if one of the parties is represented by a former employer or client, for a period of one or two years (depending on severance payment arrangements). If it is important for USPTO that you participate in the matter, notwithstanding the potential appearance problems, special authorization to participate is available through the Ethics Division.

Gifts, Bribes, and Salary Supplementation

Widely-attended Events   You may be invited to an event, such as a dinner, lunch, or reception, held by a firm or organization with interests in USPTO activities, including law firms with a patent practice, corporations, and associations of inventors. You may attend such an event if: (1) the value of the invitation is less than $20 (and total gifts you received from the person or firm inviting you will remain less than $50 for the year), or (2) your supervisor approves your attendance as in the interests of USPTO (in which case you may also bring your spouse if non-Government guests are also allowed to bring their spouses). However, you may not attend such an event if it is primarily entertainment in nature, such as a concert or sports event (unless it is the equivalent of a product demonstration).

Soliciting Gifts for USPTO Programs   USPTO may solicit, as well as accept, gifts (other than travel gifts) to support USPTO programs, provided that the gifts do not present an appearance of loss of impartiality with regard to agency programs or employees. This authority has been used in the past to obtain funding in support of conferences and similar events. However, because of the quasi-judicial nature of USPTO s activities, it is particularly important to avoid any appearance problems with regard to gift solicitations. Therefore, before soliciting gifts, you should seek specific guidance from the Ethics Division at (202) 482-5384.

Outside Employment and Activities

Service with Non-Federal Organizations   If you serve as an officer or director of an outside organization, such as a professional association, you may not participate as a USPTO employee on any matter that is likely to affect the financial interests of the organization. This may preclude you from serving with organizations that are active in matters before your office. If it would benefit USPTO to have an official

relationship with a private organization, you may be assigned as a liaison to the organization, in which case your service with the organization would be in an official capacity, rather than as an outside activity. However, you may not be assigned to serve in an official capacity as an officer or director of a non-Federal organization (other than a standards-setting body).

Lobbying the Government

<u>Representing Others Before Federal Agencies and Letters of Recommendation</u>
USPTO employees, like all Executive Branch employees, are barred from contacting officials of any Federal agency or Federal court on behalf of someone else to influence Government action. However, USPTO officials may contact other agencies in an official capacity if the communication supports an agency program, including contacting the Immigration and Naturalization Service of the Department of Justice to recommend a residency permit for an individual whose presence in the United States directly supports a USPTO program. However, such contacts may only be made to support an agency program and should be approved by a senior USPTO official.

Misuse of Government Resources

<u>Protection of Information</u>   As a USPTO employee, you must be particularly careful to safeguard non-public information to which you have access, including proprietary business information.

Seeking Employment and Post Employment Restrictions

<u>Restrictions regarding Patent Rights</u>   After leaving service with USPTO, you will be barred for one year from applying for a patent or acquiring patent rights or interests in a patent (other than by inheritance).

CITATIONS TO APPLICABLE LAW

Financial Conflicts of Interest

    18 U.S.C. § 208
    5 C.F.R. §§ 2635.502, 2640.201 - 2640.202
    35 U.S.C. § 4

Appearances of Bias (Non-Financial Conflicts of Interest)

    18 U.S.C. §§ 203 and 205
    5 C.F.R. §§ 2635.501 - 2635.503

Gifts, Bribes, and Salary Supplementation

    5 U.S.C. §§ 5342 and 5351
    15 U.S.C. § 1522
    18 U.S.C. §§ 201 and 209
    5 C.F.R. §§ 2635.201 - 2635.205, 2635.301 - 2635-304;
    41 C.F.R. Part 304-1 and Department Administrative Order 203-9

Outside Activities, Lobbying the Government, and Political Activities

    18 U.S.C. §§ 203 and 205
    5 C.F.R. §§ 2635.801 - 2635.809

Misuse of Government Position and Resources

    18 U.S.C. § 641
    5 C.F.R. §§ 2635.701 - 2635.705

Seeking Employment and Post Employment Restrictions

    18 U.S.C. § 207; 35 U.S.C. § 4; 41 U.S.C. § 423
    Exec. Order No. 12834
    5 C.F.R. Parts 2635 and 2637
    15 C.F.R. Part 15a
    37 C.F.R. Part 10

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From :	Jeffrey Simenauer <simenauerlaw@hotmail.com>
Sent :	Friday, October 15, 2004 4:52 PM
To :	issywayner@aol.com
Subject :	Following up on our telephone conversation

Dear Bill:

I just wanted to follow up with you on two subjects from our recent telephone conversation on Oct 5th.

The first subject relates to your initial contact inquiring whether I might have any search and/or opinion work to give you since you have now retired from the Patent Office. I do know of a South American company who may be interested in having a pre-examination search done before filing a U.S. patent application relating to a chemical wood-hardening process for avoiding termite damage. I know that you mentioned you were more interested in mechanical or "light" electrical work, but perhaps you might be able to handle this case. Let me know whether you are interested and, if so, what rate you would charge for doing this work.

The second subject relates to our conversation regarding the examination of Mill's lower-energy hydrogen applications. I appreciated your candor regarding the February 2003 Interview of Randy Mills' applications that you attended—commenting that "Mills is one hell of a persuasive man" and that "he came across as very convincing" at the Interview—and forwarded those comments on to Dr. Mills. He appreciated them very much, thanks.

As I told you on the phone, while I respect your continued skepticism regarding the operability of Mills' invention, I was hoping that we would be able to ultimately convince you on the merits to issue Dr. Mills his patent before you retired. As I also explained to you, what really upset me are some of the questionable actions that the PTO has taken against BlackLight. These actions include Examiner Langel's resignation from examining our cases "for moral and ethical reasons" due to instructions he was given to misrepresent the record to promote the PTO policy against all BlackLight applications wherein "allowance is not an option." As I mentioned specifically, Langel was asked to misrepresent that he was against allowing Dr. Mills' applications, when in fact he favored doing so, and that he had authority to issue Dr. Mills his patents, when he clearly had no such authority.

I appreciated your honesty Bill in confirming this official position of the Patent Office not to allow Dr. Mills' cases and I can understand why, as you stated, you couldn't tell me this while you were still working at the PTO. I had first decided that I would not ask you to go "on the record" with this information, given that we already had Examiner Langel's statements that the PTO had an "allowance is not an option" policy and that he was asked to misrepresent his authority to issue patents in our cases.

A problem has arisen, however, which has caused me to reconsider that decision. In reviewing your last Office Action in the case you examined, we came across the following statement in preparing our response that would appear to contradict what you told me on the phone about your not having authority to issue us our patent: "For the record this Examiner makes it clear that there is no committee in charge of this application, that all of the office actions in this case have been done by me alone and that I have never been told that I could not allow this application." [Emphasis added.]

In view of Examiner Langel's admission that he was told by senior PTO officials that he did not have authority to allow BlackLight's applications under any circumstances, but that he should give us the false impression that he did have such authority, my concern is that you may have been forced into a similar uncomfortable position when you made the above statement in your Office Action. As BlackLight's patent counsel, I am obligated to press this matter with you further and, knowing you to be a man of utmost integrity, I feel comfortable requesting your assistance in simply uncovering the true facts regarding the PTO's policy decisions that have been made against BlackLight.

I sincerely hope that you will accept my request and I look forward to your reply to this e-mail.

Thanks, Jeff

Law Offices Of Jeffrey A. Simenauer
2000 M Street, N.W., Suite 700
Washington, D.C.   20036-3307
Tel.: (202) 261-1001
Fax: (202) 261-1002
e-mail: simenauerlaw@hotmail.com

Form: PTO/SB/17 (Modified)
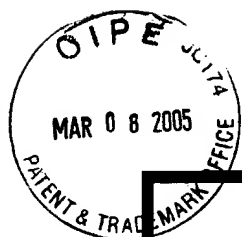
	Attorney Docket No.	9113-19-C15
REPLY/AMENDMENT FEE TRANSMITTAL	Application Number	09/110,694
	Filing Date	July 7, 1998
	First Named Inventor	Mills
	Group Art Unit	1745
AMOUNT ENCLOSED $1475	Examiner Name	Kalafut

FEE CALCULATION (fees effective 10/01/97)

CLAIMS AS AMENDED	Claims Remaining After Amendment	Highest Number Previously Paid For	Number Extra	Rate	Calculations
TOTAL CLAIMS	326	730	0 (3)	X $18.00 =	
INDEPENDENT CLAIMS	19	19	0	X $84.00 =	0

Since an Official Action set an <u>original</u> due date of 5 Months , petition is hereby made for an extension to cover the date this reply is filed for which the requisite fee is enclosed (1 month ($110); 2 months ($400); 3 months ($950); 4 months ($1,510); 5 months ($2,060)): 5 months	2,160
Request for Continued Prosecution	+790
Total of above Calculations =	$2950
Reduction by 50% for filing by small entity (37 CFR 1.9, 1.27 & 1.28)	-1,475
TOTAL FEES DUE =	$1,475

(1) If entry (1) is less than entry (2), entry (3) is "0".
(2) If entry (2) is less than 20, change entry (2) to "20".
(4) If entry (4) is less than entry (5), entry (6) is "0".
(5) If entry (5) is less than 3, change entry (5) to "3".

METHOD OF PAYMENT

[X] Check enclosed as payment.

[ ] Charge "TOTAL FEES DUE" to the Deposit Account No., below.

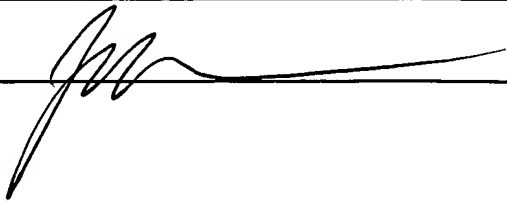## AUTHORIZATION

[X] If the above-noted "AMOUNT ENCLOSED" is not correct, the Commissioner is hereby authorized to credit any overpayment or charge any additional fees under 37 CFR 1.16 or 1.17 necessary to maintain pendency of the present application to:

Deposit Account No.:	50-0687
OrderNo.: (Client/Matter)	62-226

SUBMITTED BY: Manelli Denison & Selter, PLLC

Typed Name	Jeffrey S. Melcher	Reg. No.	35,950
Signature		Date	March 8, 2005